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THE RELATIONSHIP BETWEEN PROFESSIONAL DEVELOPMENT AND THE IMPLEMENTATION OF 1:1 TECHNOLOGY IN THE MIDDLE SCHOOL CLASSROOM

A DISSERTATION

SUBMITTED TO THE GRADUATE SCHOOL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE

DOCTOR OF EDUCATION

BY

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BALL STATE UNIVERSITY

MUNCIE, IN

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BY

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BALL STATE UNIVERSITY

MUNCIE, INDIANA

December 2018

DEDICATION

To Gavin, Gabriel, and Garrett otherwise known as G1, G2, and G3. I hope through my writing of this dissertation you have observed the perseverance it takes to complete big things in your life. Never hesitate to set lofty goals for yourselves and persevere to achieve them.

To my parents, JoDohn and Louise Glaze. Thank you for the gift of an education. I know sending me to college was a huge sacrifice that included long hours building crafts and woodworking. Your support of me has been immeasurable and I am so proud to be your son. I strive every day to be the incredible parent you both were to me.

To my friend and teacher John Sedwick. Thank you for sharpening my thinking, listening to my rants, and believing in me. Teachers make a difference in your life and you have certainly done that for me.

Finally, to Anita, my wife. You are my rock. Over the last 20 years you have encouraged and believed in me. I know the last few months and the years of dissertation work have been difficult, and you have shouldered so much responsibility. I am blessed to have you as my wife and love you so very much.

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Dr. Quick, you helped me start my administrative career 16 years ago as my principal internship instructor. It has been a pleasure working with you through my Ed.S. and now Ed.D. With gentle nudging, you push me to work harder and strive for excellence. You encourage me when I am down and were so incredibly supportive through my coronary bypass surgery. As I say to you all the time Dr. Quick, You Are the Best!

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CHAPTER ONE

INTRODUCTION

In the late 20th century, advances in personal computing and access to the World Wide Web brought about new instructional possibilities in school districts throughout the world. In the early 1990's, reports of 1:1 computing as an instructional tool began to emerge internationally in education (Penuel, 2014). By 2000, some states within the United States and countries throughout the globe developed student-centered technology models to promote new ways of learning and thinking.

Today, 1:1 initiatives that provide laptop computers or tablet devices and Internet access to students for use at school have expanded rapidly across the United States and the world. In 2015, 54% of K-12 students in the United States had access to mobile/1:1 technology devices, doubling the percentage from 2012 (Molner, 2015). In Indiana, 67% of school districts have 1:1 initiatives in at least one grade level (Indiana Department of Education, 2016). Initiatives like this facilitate the transition in schools from occasional or supplemental use of computers, to more frequent and integral use of technology. Ubiquitous, 24/7 access makes it possible for students to access a wider array of resources to support their learning, to communicate with peers and their teachers, and to become fluent in their use of the technological tools of the 21st Century workplace.

Placing technology in the classroom alone does not change learning outcomes for students. Significant attention must be paid to the role of teacher in the technology rich classroom. Eighty-one percent of teachers agree the technology in the classroom enables students to enjoy more hands-on experiences during lessons. Additionally, 90% of teachers believe modern technology in the classroom is important to achieving success in preparing students (Ertmer & Ottenbreit-Leftwich, 2010). To prepare teachers for technology integration, schools in the United States have spent $18 billion in technology related professional development since 2015 (Learning Forward, 2012). Professional development typically includes job embedded, peer-to-peer, traditional whole group, professional learning communities, and online virtual training.

School districts have spent both large amounts of dollars and time in professional development for teachers in technology. However, 60% of teachers feel inadequately prepared to use technology in the classroom. Additionally, 50% of teachers claim a lack of support using technology in their classroom. Still, 37% of teachers want to use technology in their classroom, but they feel they do not know how (Samsung Electronics America, 2015).

Despite the immersion and interest in technology, this investment in devices and professional development has shown little to no change in student achievement (ISTE, 2007). School officials note changes in student engagement and improved technology skills, but beside small improvements in writing and mathematics, schools have not received a return on investment technology initiatives in overall student achievement.

Statement of the Problem

Public schools in the United States now provide at least one computer for every five students. To support the use of devices, school districts spend $3 billion per year on digital content. In the last two years, the federal government has allocated funds to make high-speed

Internet and free online teaching resources available to even the most rural and remote schools (United States Department of Education, 2015). In 2015-16, more standardized tests for the elementary and middle grades were administered via technology than by paper and pencil (Herold, 2016).

The immersion of technology in our classrooms is evident. However, a significant body of research clearly expresses that districts have been slow to transform instructional practice, despite the influx of new technology into classrooms (November, 2013). Only a very limited amount of evidence has indicated that technology and online learning improves student achievement (Means et al., 2009).

So why does technology seemingly not provide the return on investment? The education community would cite a lack of professional development in the practices of technology implementation. However, $18 billion is spent annually on teacher professional development, roughly about 8%-9% of overall school expenditures (National Teachers Project, 2015).

The relationship of technology immersion and student achievement may have little to do with the amount of professional development, but the effectiveness of the training. Put simply, effective professional development for teachers is job-embedded and extended over a period, which makes it both relevant and authentic. Teachers deem professional development relevant when it directly addresses their specific needs and concerns (Guskey, 1995; Learning Forward (2012), or when they see a connection between a learning experience and their daily responsibilities (Tate, 2009).

The duration (number of teacher contact hours) of professional development is also considered an important part of effectiveness. Effective professional development provides teachers with many opportunities to interact with ideas and procedures or practice new skills (Learning Forward, 2012). Research (i.e., Lieberman & Mace, 2008) has shown that teacher learning and changes in teaching practice involve a recursive and continual process that takes place over time. In fact, lasting change typically takes a minimum of three to five years (Guskey, 1995).

The problem schools face with effective technology integration is the speed of implementation keeping pace with teacher professional development. What is unknown is the point where schools can solidify a return on investment in relation to student achievement. The implementation and professional development model that yields the highest acquisition of technology integration is also unknown. Finally, how have instructional practices changed in classrooms with high levels of technology integration?

Purpose of the Study

The purpose of this study is to identify the relationship between effective professional development and the level of implementation of 1:1 technology integration in the middle school classroom. The effectiveness of professional development and instructional practices will be measured by a teacher observation, a survey, and focus groups using the International Society for Technology in Education (ISTE) Teacher Standards. The independent variables include: initial comfort level with technology, gender, age, years of experience, content area, and educational setting (general education/special education/honors). Further, the dependent variables include the measurement of both technology integration measured by SAMR and ISTE-Teacher Standards using observational rubrics.

Significance of the Study

This study will add to the body of work on technology integration and professional development. First, this study will ascertain what practices in the two districts, (which include professional development, digital leadership, building culture, and/or teacher initiative), yield the deepest level of technology integration in the middle school classroom. Secondly, this study will investigate how teachers think instruction has changed as part of the technology integration initiative. Third, this study will examine if technology integration has affected student achievement in either district.

One district is in its third year of 1:1 implementation, and the other in its second year. During this time frame, the question remains, has there been a significant change positive or negatively in student achievement? Also, does the timeline for professional development have any bearing on the level of technology integration?

This study adds to scholarly research and literature in the field by exploring best practices in technology integration through reflection from practitioners to identify professional development that is enduring and transformational to instructional practice with devices. The study will identify influences within a building that cultivate the best environment for technology integration which include teacher efficacy, instructional leadership, or prevailing building culture. Finally, this study will investigate student achievement on ISTEP and NWEA as it relates to technology integration.

The study will improve practice and policy by isolating specific strategies that yield the deepest implementation whether job embedded instructional coaching, peer coaching, or asynchronous individual teacher initiated professional development. Furthermore, this study can identify the significance of concurrent or pre-implementation practices on the overall success of technology initiatives. Lastly, the study will identify the influences of building culture on the acceptance and level of implementation of the technology initiative.

Research Questions

The research questions that guided this study were:

R_1 Based on the perceptions of middle school teachers, what practices motivated the deepest level of technology implementation (i.e. formal professional development pre-implementation or concurrent to implementation, digital leadership, teacher initiative, or school culture)?

R_2 How do stakeholders perceive changes in instructional practices have occurred since the technology implementation based on the ISTE-Coaching Standards?

R_3 When comparing two schools, one using pre-implementation practices and the other concurrent practices, which school has the deepest level of implementation measured by ISTE-Coaching Standards?

R_4 What are the differences in ISTEP+ and NWEA assessment data, comparing pre- and post-implementation data of 1:1 technology in both districts?

Delimitations

Delimitations speak to how the scope of the study was narrowed (Creswell, 1998). Delimitations to this research are as follows:

1. The study will involve two middle schools in two districts in central Indiana. One district received a Race to the Top Grant in 2012 and quickly implemented its 1:1 initiative. The other district implemented the 1:1 initiative gradually. Although the sample size might limit generalizability of results, I believe both schools can provide the needed reflection on practice as to technology implementation levels.

2. Both districts are in the early stages (first-three years) of 1:1 technology implementations. Schools in early implementation are still struggling with change and attempting to find solutions to the problems encountered.

3. One district is larger than the other, but both possess similar demographics. Since the study focuses on high poverty districts the student demographics will provide the more pertinent data versus the differences in student enrollment.

4. The sample for the study will consist of teachers in both middle school buildings. The entire teaching staff will have the opportunity to participate in the research survey.

5. Core content area teachers (those teachers teaching English/language arts, math, science, and social studies) will participate in classroom observations and focus groups. Both districts have focused professional development in the core content areas of English/language arts, math, science, and social studies.

6. Classroom observation teachers will be randomly selected, while focus group teachers will be selected by grade level core content teams of English/language arts, math,

science, and social studies teachers in grade 6-8. Randomly selected groups will alleviate concerns of bias.

Definition of Terms

The following definitions provide a common language for the researcher, fellow educators, and readers based on the context of the study:

1:1 technology initiatives: (sometimes abbreviated as "1:1 initiatives") refers to academic institutions, such as schools or colleges, issuing each enrolled student an electronic device such a laptop, tablet, or other mobile devices (Bebel, Damian; Rachel Kay, 2010).

Technology integration*:* The routine and transparent use of technology in the classroom (Pierson, 1999).

Technology Implementation: The inception and development of a plan to use technology in an educational setting (Whitehead, 2003)

SAMR Model*:* The Substitution Augmentation Modification Redefinition Model offers a method of seeing how computer technology might impact teaching and learning. It also shows a progression that adopters of educational technology often follow as they progress through teaching and learning with technology (Puentedura, 2012).

School Culture*:* The underlying norm values and beliefs that teachers and administrators hold about teaching and learning (Peterson, 2012)

Digital Leadership*:* George Couros (2013) defined digital leadership as using the vast reach of technology to improve the lives, well-being, and circumstances of others. He further declared digital leadership empowers others in the use technology. Eric Sheninger (2014) viewed digital leadership as a process that provides teachers and students with essential skill sets such as creativity, communication, collaboration, critical thinking, problem solving, technological proficiency, and global awareness.

Teacher initiative*:* Teacher initiative (efficacy) can be defined as teachers' beliefs in their abilities to organize and execute courses of action necessary to bring about desired results (Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998).

Job embedded professional development*:* Job-embedded is professional development that is grounded in day-to-day teaching practice and is designed to enhance teachers' content-specific instructional practices with the intent of improving student learning (Darling-Hammond & McLaughlin, 1995).

Active learning*:* Any instructional method that engages students in the learning process. Learning that requires students to do meaningful learning activities and think about what they are doing (Bonwell & Eison,1991).

Technological literacy*:* Also known as computer literacy, this is the ability to use computers and related technology efficiently (Computerized Manufacturing Automation: Employment, Education, and the Workplace, 1984).

Professional learning communities*:* Extending classroom practice into the community; bringing community personnel into the school to enhance the curriculum and learning tasks for students; or engaging students, teachers, and administrators simultaneously in learning (Hord, 1997).

***TPACK model**:* Technological Pedagogical Content Knowledge (TPACK) is a framework that identifies the knowledge teachers need to teach effectively with technology (Mishra & Koehler, 2006).

Summary

Access to technology has ushered in a time in education where a world of information is literally “a click” away. Access to technology should bring about a change in instructional practices that can reinvent learning for our students. However, in many instances instructional practices have remained constant with the only change being a device available to students.

To improve instruction and therefore student outcomes, professional development best practices must be utilized in the implementation of technology into the classroom. This study will identify practices that yield the deepest implementation. The level of the implementation will be analyzed by reviewing the timing (pre-and concurrent to implementation), digital leadership, teacher initiative, or school culture. In Chapter 2 a review of the literature, as it pertains to professional development and technology integration, will be further explored. Chapter 3 provides the research methods used in this study. Chapter 4 will share the results and findings of the of study. Finally, Chapter 5 will present conclusions, recommendations and implications of the study.

CHAPTER TWO

LITERATURE REVIEW

This chapter explores the literature review for these topics: 1:1 technology initiatives, the role and perceptions of professional development, and professional development with technology integration. First, the focus will be on the research of 1:1 technology, which includes topics surrounding the history, barriers, and learning changes resulting from 1:1. Second, I focus on professional development barriers and review standards for best practices. Finally, I turn to professional development specifically for technology integration with models and standards to measure successful technology implementation.

Conceptual Framework

This study examines practices and influences within the middle school setting which provide the deepest technology integration implementation as described by International Society of Technology for Education Standards for Coaches (ISTE-C) and Learning Forward Professional Development Standards. The instruments used to measure implementation are the Technology Integration Matrix (Tim-O) and the Technology Uses and Perceptions Survey (TUPS). Figure 1 illustrates the conceptual framework for this study, which has the combination of the ISTE-C and Learning Forward Standards at the core of this research. The standards, located on the inside of the conceptual framework, identify best practices that can influence technology integration and implementation. On the outside are five actions from the human perspective that have influence on a successful implementation. These actions include: school culture, digital leadership, pre-implementation practices, concurrent implementation practices and teacher initiative. The bottom of the Figure 1 Conceptual Framework reflects how ISTE-C Standards, Learning Forward Professional Development Standards, and the five actions influence Student Achievement measured by ISTEP and NWEA assessments.

One of the five actions, school culture, is defined by Dr. Kent Peterson as, “a set of norms, values and beliefs, rituals and ceremonies, symbols and stories that make up the 'persona' of the school" (Peterson & Deal 1998). A positive school culture is considered one that celebrates successes, emphasizes accomplishments and collaboration, and fosters a commitment to staff and student learning. A negative school culture is defined as one that blames students for lack of progress, discourages collaboration, and breed hostility among staff (Peterson, 2002).

In 2014, Eric Sheninger conceptualized digital leadership, another of the five actions in Figure 1, by claiming “Digital Leadership requires a shift in leadership style from one of mandates, directives, and buy-in, to one grounded in empowerment, support, and embracement as keys to sustainable change (page 75).” Sheninger outlined seven pillars of digital leadership that he believed are crucial to moving technology integration forward. The seven pillars include: *communication, public relations*, *branding*, *student engagement and learning*, *professional growth and development*, *re-envisioning learning spaces and environments*, and *opportunity*.

Professional development is critical to any new initiative, but does the timing of professional development influence technology implementation? For this study, pre-implementation practices are considered targeted professional development (PD). This targeted PD occurs before students receive devices, specific pilots with devices that conclude content areas or specific grade levels, and early staff device implementation ahead of students. Concurrent practice for this study is defined as device rollout for both staff and student simultaneously. No device pilots exist, and no pre-implementation professional development has occurred for a site designated as *concurrent practices*. Professional development is personalized for teachers with a combination of job embedded, peer-to-peer, and online learning training models, which can have an influence on the level of technology integration.

Teacher initiative is the action teachers take and their willingness to get things done. In correlation with technology integration, does teacher initiative effect the level of integration? Today's digital environment provides unlimited opportunities to learn from colleagues around the world. In fact, abundant learning is often only a Google Search away.

Finally, using ISTE-C and Learning Forward Standards as a framework, how does the level of technology implementation and forces for change affect the level of student achievement measured by Indiana Statewide Testing for Educational Progress (ISTEP) and Northwest Evaluation Association (NWEA)?

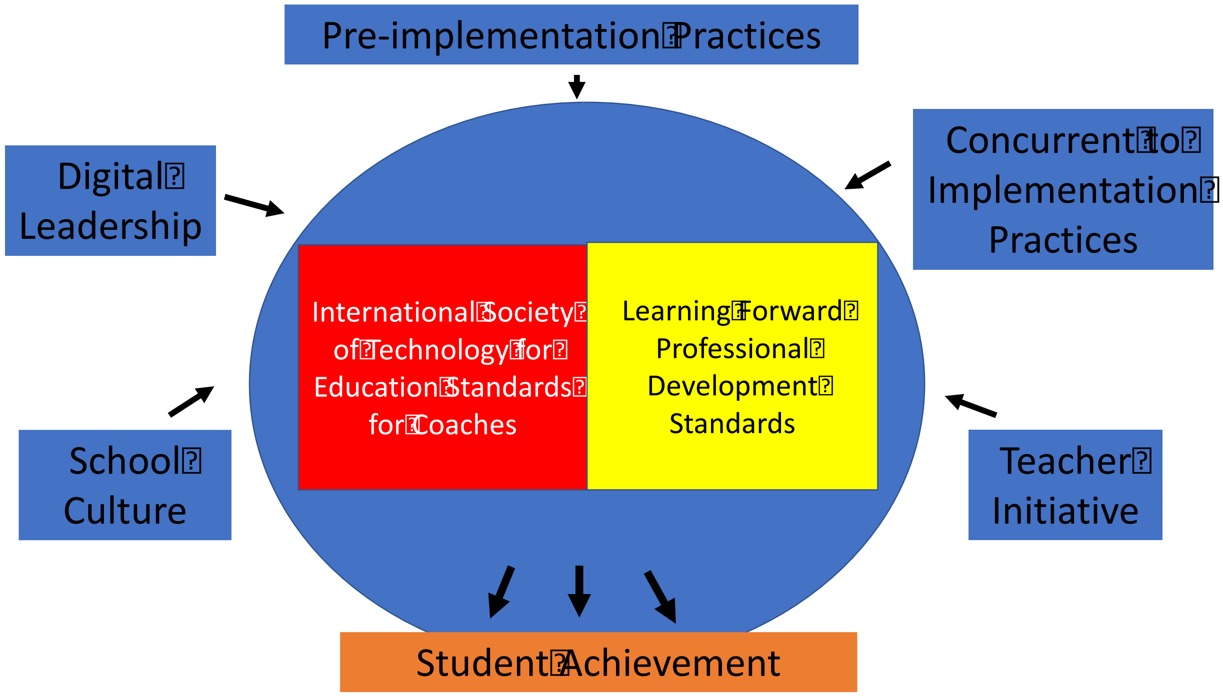

Figure 1: Conceptual Framework that was created by the author

As I was delving into these sets of standards, it became apparent that these were closely aligned. *Figure* 2 identifies four major ISTE-C standards that have a close association with four standards from Learning Forward. The four ISTE-C standards include *visionary leadership, content knowledge and professional growth, teaching learning and assessments*, and *professional development and program evaluation*. Standards from Learning Forward include *leadership, learning designs, data* and *outcomes*. By aligning these standards, I provide a framework that could be used to determine how the indicators guide schools in the implementation of technology in the classroom.

Visionary leadership from ISTE-C and Learning Forward's *leadership* align closely due to the importance of leadership in professional development. Leaders establish support networks, a comprehensive vision, and an opportunity to develop capacity in teachers and students. ISTE-C *content knowledge and professional growth* standards align to Learning Forward's *learning designs*. Both establish the crucial need for practitioners to have a strong theoretical and pedagogical knowledge about the content they are expected to deliver. Next, ISTE-C's *teaching, learning, and assessment* compares closely to Learning Forward's *data* standards. Both standards discuss the strong use of assessment and data to determine the educational needs of students. Finally, ISTE-C's *professional development and program evaluation* aligns with Learning Forward's *outcomes* by promoting ways to establish needs and assigning further professional development resources in order to attain appropriate outcomes.

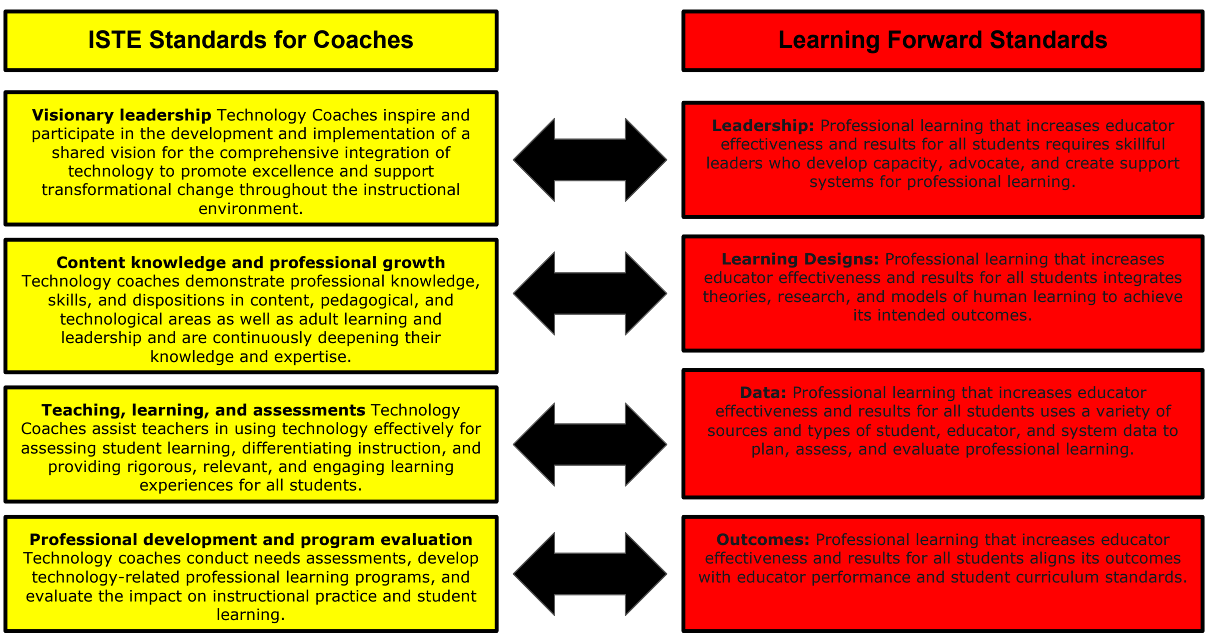

Figure 2: Standards alignment of the ISTE Standards for technology coaches and Learning Forward Standards.

History of 1:1 Computing

The birth of 1:1 computing concept emerged at the University of Illinois in the early 1960's, where classroom computer terminals were linked to a mainframe computer. In this classroom, students listened to lectures recorded through an audio device. This system, called Computer-based Education Research Laboratory (Wolley, 1994), was the invention of engineer and professor Don Blizter. His purpose was to use computers as a teaching tool instead of performing redundant tasks. By mid-decade, Stanford University piloted the use of Teletypes (electromechanical typewriters that can be used to send and receive typed messages) to teach basic spelling and mathematics at the Palo Alto Unified School District in California.

Through this pilot, Patrick Suppes and Richard Atkinson sought to free students from whole group instruction, and to develop individualized, instructional strategies that allowed the learner to correct her responses through rapid feedback. Most importantly, the self-paced program allowed students to take an active role in the learning process. Mastery was obtained through drill-and-practice. The drill-and-practice concept persisted in use of computers in the learning environment for the next 50 years.

The first modern 1:1 program began in 1986 with Apple's Classrooms of Tomorrow. In the Classrooms of Tomorrow, technology was viewed as a tool for learning and a medium for thinking, collaborating, and communicating (Baker & Gearhart, 1993). This first program involved outfitting a classroom with desktop computers, on which the students would complete most of their work. After eight years of implementation, the outcomes were monumental. The study concluded, "[m]eaningful use of technology in schools goes far beyond just dropping technology into classrooms" (Dwyer, 2008, p. 6). Additionally, students' academic advances increased the most when teachers moved away from traditional teacher centered learning into project and inquiry-based models.

Through the late 20th and early 21st Century, the number of computers in schools increased. The national ratio of students to computers was 123:1 in 1983 and changed to 4:1 in 2002 (Bebell et al., 2010). Schools invested in large-scale lab-based technology, such as Apple computers and IBM clones, as the desktops became more affordable and accessible. Damian Bebell and Rachel Kay, professors at Boston College, stated that "although access to lab-based computers has increased, teachers and students in traditional school environments generally report using computers in schools for only a small amount of time each day, demonstrating the need for even more student access to devices" (Bebell et al., 2010 page 6).

In 2002, the state of Maine made the first large-scale investment in 1:1 computing. The state signed a $37 million contract with Apple that provided laptops to 33,000 middle school students and 3,000 teachers (Maine Department of Education, 2016). The contract was extended in 2006 and expanded in 2009 to include some high schools (Maine Department of Education, 2016). The Maine initiative used a combination of both laptops and tablet devices. Since 2009, laptop and tablet use in schools have given way to mobile devices, such as iPads and Chromebooks. At the same time, the impact of mobile devices in recent years has dramatically increased to nearly two-thirds of Americans owning such a device. Specifically, with school-aged children, 80% of high school students reported owning a smartphone. However, when considering a learning tool, 38% of students prefer laptops and Chromebooks (Piehler, 2015).

Impact of Technology on Learning in the 1:1 Classroom

In schools, mobile devices have become an inexpensive substitution for desktop and laptop devices, allowing more schools to move to the 1:1 technology environment. In one year's, time, between 2014 and 2015, the implementation of 1:1 device in schools throughout the United States, has increased from 14% to 19% (Piehler, 2015). In Indiana, implementation is higher, with 26% 1:1 in all grades, 21% in most grades, and 20% in some grades as reported by the 2016 Indiana Department of Education annual technology plan (Indiana Department of Education, 2016). However, just like the wide variance among schools in Indiana, there are also different models of 1:1 implementation with varying degrees of impact on learning.

Claims have been made that 1:1 initiative have made little to no impact on student learning (such as, Silvernail & Gritter, 2007). However, some research in this area demonstrates opposite outcomes. Academic achievement results of 1:1 program have been demonstrated with writing skills. The state of Maine implemented 1:1 computing and student-focused teaching strategies, such as critical thinking, communication, and collaboration (the 3C's), in their middle schools in 2002. Maine students showed significant improvement in writing scores on their statewide testing (Silvernail & Gritter, 2007). This study would argue that increases in achievement are coupled with device use and changes in teacher pedagogy and practice. The same study also found that the more extensively students used their laptops, the better they scored (Maine Department of Education, 2016), meaning familiarity with a device can make a difference in student achievement. Lowther et al.'s (2012) study also indicated positive achievement gains in students' writing scores with a combination of laptop use and teacher professional development.

Additional studies observed gains in both writing and literacy skills. One of those studies analyzed what sometimes occurs as students transition from "learning to read" to "reading to learn" typically in grade 3 to grade 4. The study found that students in a laptop program outperformed their peers in the control group in literacy response and analysis, as well as writing strategies (Bebell et al., 2010). Positive impacts also affect students' grade point averages.

One study compared cumulative grade point averages of middle school students at the end of a year with laptops to the year prior without laptops (Lei & Zhao, 2008). The researchers reported a marginally significant ($t = 1.97$, $p = 0.051$) increase in average student GPA using a pre- and post-assessment. The study also found significant gains in students' technological proficiency.

Other benefits have also been demonstrated with 1:1 beyond achievement. In a study of 1:1 in five Massachusetts middle schools performed by Bebell and Kay (2010), teacher-observed engagement and student motivation both increased. Of the teachers who responded to the survey, 83% indicated that "traditional" students were more engaged in the 1:1 setting. Results also indicated that 71% of the studied teachers believed that students were more motivated with laptops. Teachers initially concerned about distractions of students with laptops found their students' academic engagement as a substantial benefit of 1:1 computing programs (Bebell et al., 2010).

Barriers to 1:1 Technology Integration

Many 1:1 technology initiatives fail to yield the instructional, academic, or student achievement changes in relationship to the financial investment. Often, 1:1 initiatives are touted for increases in student engagement as a selling point for boards of education, but fail to generate true instructional and specific pedagogical change needed to prepare students for Twenty-First Century skills. One of the barriers to 1:1 technology is a lack of vision and leadership at the school level (Machado & Chung, 2015).

Without a technology vision that is communicated to all stakeholders, school leaders often fail to fully understand and support the role of technology in the school. Many authors suggested that the building principal fills this central organizational and leadership need (Richardson, Flora, & Bathon, 2013). The most effective principals develop a vision and use this vision to develop a supportive learning community (Leithwood & Riehl, 2003). School policies flow from the top down and from the bottom up. Therefore, the attitudes toward technology and the actual effectiveness of technology integration in classrooms are shaped by the principal's vision and leadership for their school— in addition to teacher preparation (Machado, 2015).

Beyond vision and leadership, the financial costs due to devices and infrastructure continue to create barriers to 1:1 initiatives. Schools in the United States spend an estimated $56 billion dollars on technology each year, approximately $400 per student per year (Johnson, 2012). The education sector has often failed to experience transformation through the use of technology, in large part due to the challenge of allocating the necessary initial capital budget to start and sustain technology initiatives (Project Red, 2015). In school districts, there is not only the cost for devices, but also the cost for infrastructure improvements. Most districts use federal funding or educational grants, according to a June 2012 report from Hanover Research Council. A significant number of districts also rely on bonds to pay for the programs (Rhor, 2014).

To prepare and assist school districts with the financial barriers, the United States Department of Education provides guidance for district to fund 1:1 technology through "Innovative Planning" (Office of Educational Technology, 2016). These guidelines are included in this United States Department of Education document:

- **Leveraging economies of scale**: At both the multi-district and multi-state levels, school systems can negotiate more favorable rates with vendors by collaborating with others seeking similar devices/services.
- **Public-private partnerships:** Cross-sector collaboration can prove mutually beneficial. What major businesses/industries are in the region? They have a stake in ensuring students graduate digitally literate and may be willing to partner in funding, device donation, connectivity-sharing, or training to advance that purpose.
- **Cross-agency coordination:** Some states and districts leverage higher education or medical facility resources to boost education access.
- **Device refurbishment:** Repairing, upgrading, and reusing devices business/community members no longer need can create both an educational opportunity and a source of low-cost devices.
- **BYOD (Bring Your Own Device) and student wireless access:** Some states and districts leverage the devices students already own, carefully considering privacy, security, and logistical issues. In other locales, it may be possible to negotiate very low

rates for student wireless devices and services, which they could use both in and out of school.

- **Strategic decommissioning:** What activities or resources are no longer needed? Areas to consider include paper textbooks, copy machines and supplies, fax machines and supplies, copper-line phone service, paper supplies, consumable workbooks, in-person trainings where virtual or peer-to-peer options exist, printing (schedules, grades, announcements etc.), and others, depending on context.

Beyond financial barriers, an additional barrier is that of poor visioning and professional learning for teachers. Teachers consider problems with equipment, scheduling difficulties (with lab-based technology), software availability, and lack of training as barriers to technology implementation (Wright, 2011). With these barriers in mind, teachers may believe that technology integration is not worthwhile and can be exhausting to use (Wright & Wilson, 2012). A four-year study of "technology enhanced" experiences for teachers found that technology use did not bring about fundamental changes in instruction, but instead either replaced, improved, or extended traditional instruction (Wright & Wilson, 2011). Allowing for an *entry* level integration practices as defined by TIM-O levels of technology integration would translate to "passive student learning." Hew and Brush (2007) analyzed existing empirical studies of technology integration from 1995 to spring 2006 in the United States and other countries. Out of six categories of barriers examined, two were related to teachers' behavior: the lack of specific knowledge and skills about technology integration and attitudes and beliefs toward technology (Gu, Zhu, & Guo, 2012). Bingimlas (2009) found teachers had a strong desire for integrating technology into classrooms, but lack confidence and competence, or positive attitudes toward technology.

Hooper and Rieber (1999) described five phases of teachers' use of technology: familiarization, utilization, integration, reorientation, and evolution. The five stages are defined as: 1) *Familiarization*, learning the "how-tos" of using technology; 2) *Utilization*, trying the technology, but will not miss it if taken away; 3) *Integration*, using technology for certain tasks and designated uses; 4) *Reorientation*, using technology for more than delivery of content; focus is more on student learning and 5) *Evolution*, continuing to evolve, adapting and integrating technology. Typically, teachers do not progress past the *utilization* stage to the *evolution* stage, where they use technology seamlessly in their instruction (Wright, 2011). Limited levels of implementation often negatively affect student opportunity. Schools want the positive perception and accolades 1:1 initiatives bring, but schools often fail in carefully preparing for their instructional staff needs and desires to truly affect instructional change.

Development of a promising technology does not guarantee that it will achieve widespread use. Teachers will vary in their interest in adopting a new approach, and in their competence to use it. Constructs and tools from change process research can be instructive in increasing the use of technology. The extent and quality-of-use of new approaches can be greatly enhanced when there is understanding of how people change. Regardless of the potential power of a technology, until it is used, and used well, the promised outcomes will not be attained.

In *Technology's Achilles Heel: Achieving High-Quality Implementation,* Gene Hall (2010), asserted that in order for innovation to be disseminated we must ask four questions: 1. Is it being used? 2. How well is it being used? 3. What factors are affecting its use/nonuse? and finally, 4. What are the outcomes? Hall believed these questions are important beginning points to accepting that different implementers are not likely to use the technology exactly as the developer envisioned. Exact replication from classroom to classroom is highly unlikely. Replication of implementation can often be considered a barrier. To this end, Hall (2010) developed "The Implementation Bridge." The concept of the implementation bridge is to demonstrate the support teachers need in order to fully implement technology in the classroom.

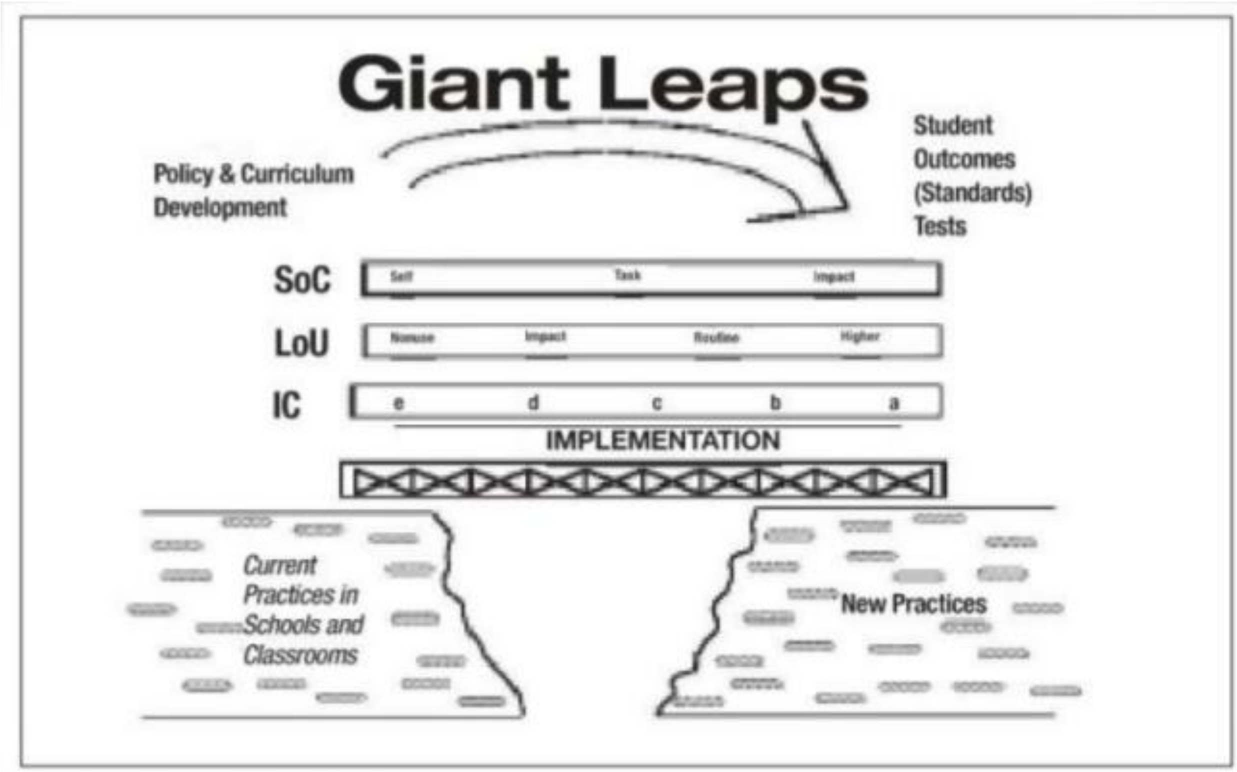

Figure 3: The Implementation Bridge. Hall (2014)

The implementation bridge illustrates, from top to bottom, the beginning and ending points for change. The top of *Figure 3* demonstrates the starting point of policy/curriculum development and how the implementation bridge connects strategies to generate student outcomes. The middle of *Figure 3* illustrates the implementation bridge and its three diagnostic dimensions of Stages of Concern (SoC), Levels of Use (LoU), and Innovative Configurations (IC). *Stages of Concern* addresses the personal/affective aspects of change, preoccupations and moments of satisfaction for teachers when implementing new approaches. *Innovation Configurations* addresses the idea that each implementer does not necessarily use the same form of the change. Implementers may say they are using “it,” but what is in operation within each classroom and school can be significantly different. The bottom of the Figure 3 demonstrates how the implementation bridge moves teachers from current practices to new practices.

Professional Development in the Context of Student Learning

The National Teacher Project estimated that schools in the United States spend approximately $18 billion annually on professional development for teachers, roughly 8%-9% of overall school expenditures (National Teachers Project, 2015). The term professional development, whether in business or schools, is typically defined as a “formal process such as a conference, seminar, or workshop where collaborative learning happens among members of a work team” (Mizell, 2010, p. 5). In school settings, professional development can be at the district, school, grade, subject area, classroom and/or department. In the school setting, professional development is offered during the school day, the summer, as job-embedded, as well as before and after school. In some districts, teachers spend approximately 10% of an entire school year in professional development activities (Mizell, 2010). With so much time and resources allocated to professional development, it is important to ensure what processes yield the highest return on student learning outcomes.

In this section on professional development, the main strands discussed begin with the Learning Forward Standards, which represent the national exemplar for professional development. Next, the ISTE-C standards are described in detail. The common themes from both the Learning Forward Standards and ISTE-C standards comprise the next section. Finally, the section ends with an overview of research on best practices for student outcomes using technology.

Learning Forward Standards for Student Learning

Learning Forward, formerly called the National Staff Development Council, is an organization dedicated to the improvement of professional development in schools. Learning Forward has outlined standards for successful professional development that include learning communities, leadership, resources, data, learning design, implementation, and outcomes. The Standards for Student Learning include the following:

> **Standard 1: Learning communities**. Professional learning that increases educator effectiveness and results for all students occurs within learning communities committed to continuous improvement, collective responsibility, and goal alignment.
>
> **Standard 2: Leadership.** Professional learning that increases educator effectiveness and results for all students requires skillful leaders who develop capacity, advocate, and create support systems for professional learning.

Standard 3: Resources. Professional learning that increases educator effectiveness and results for all students requires prioritizing, monitoring, and coordinating resources for educator learning.

Standard 4: Data. Professional learning that increases educator effectiveness and results for all students' uses a variety of sources and types of student, educator, and system data to plan, assess, and evaluate professional learning.

Standard 5: Learning designs. Professional learning that increases educator effectiveness and results for all students integrates theories, research, and models of human learning to achieve its intended outcomes.

Standard 6: Implementation. Professional learning that increases educator effectiveness and results for all students applies research on change and sustains support for implementation of professional learning for long-term change.

Standard 7: Outcomes. Professional learning that increases educator effectiveness and results for all students aligns its outcomes with educator performance and student curriculum standards.

Learning Forward Standard 1 focuses on the importance of professional learning and the power of learning communities to promote "continuous improvement, collective responsibility, and goal alignment" (Learning Forward, 2012). In a two-year case study, Cifuentes, Maxwell, and Bulu (2011) provided a rich description of teachers' experiences during two years of technology-integration professional development and a description of effective professional development strategies. In the conclusion of the study, Cifuentes, Maxwell, and Bulu (2011) declared this benefit of professional learning communities:

> Collaboration works because it engages stakeholders as peers using skillful means to facilitate dialogue, mutual learning, shared responsibility, and action. By providing a powerful, transforming experience, it allows stakeholders to engage and act together as fellow human beings to address mutual concerns (p. 80).

Instructional leadership is the basis for Learning Forward Standard 2. Standard 2 declares the need to for leaders to develop capacity, advocate, and create support systems for professional learning. Successful leaders define their values and vision to raise expectations in order to set direction and build trust for organizational change (Whitehead, 2013). Furthermore, Whitehead stated, “Successful leaders must be able to anticipate change and adapt administrative roles and responsibilities to meet the needs of students and teachers” (p. 22). Alan November claimed that leaders also must learn how to support risk-taking teachers and creating cohorts of teachers across disciplines and grades that can promote student-learning change (November, 2013).

Prioritizing, monitoring, and coordinating resources allows for improved teacher effectiveness in standard 3. The instructional leader must communicate until long-term change mindsets are firmly in place. They must confirm that digital technologies are here to stay, that they are important, and that they will continuously and disruptively foster numerous changes in schooling practice. Those mindsets then must be continually nurtured and supported in order to end complacency, or a return to traditional modes of operating (Kotter, 2008).

It is important to take a systemic, continuous improvement approach to data analysis. Educators should gather and analyze data to gain a better understanding of the system that is producing the current results in a school or district (Murray, 2014). Learning Forwards view student data as a vital component of professional learning. Standard 4 states, effective professional development has a variety of sources and types of students, educators, and system data to plan, assess, and evaluate professional learning.

Standards 5 and 6 are based on the learning design, research and implementation. Durant, Brunvand, Ellsworth, & Şendağ (2012) stated: "research-based professional development that is sustained, student-centered, participatory, and supported by adequate resources can have a significant impact on teacher learning about specific technologies and the level of integration of these technologies in the classroom, demonstrating the effectiveness of research-based practice and scope of implementation on teacher and student learning (p. 4321)."

Outcomes are the critical measure of professional development. Did the professional development yield a change in student achievement, building level culture and climate, or pedagogical understanding? When the content of professional learning integrates student curriculum and educator performance standards, the link between educator learning and student learning becomes explicit, increasing the likelihood that professional learning contributes to increased student learning. When systems increase the stakes for students by demanding high, equitable outcomes, the stakes for professional learning increase as well (Learning Forward, 2012).

The Role of Professional Development (ISTE-C Standards) in the 1:1 Environment

A long-standing notion in education is that implementing a new educational technology will transform the classroom and student learning (Groff & Mouza, 2008). Even though students have access and readily use 21st Century technologies outside of school, educators and schools have been slow to embrace technology for instructional purposes to enhance student learning (Downes & Bishop, 2012). The complex and challenging task of effectively integrating classroom technology may be evident by the slow integration process in K-12 schools (Forthe, 2012; Groff & Mouza, 2008). Research has consistently indicated that high-quality professional development activities are longer in duration (contact hours plus follow-up), provide access to new technologies for teaching and learning, actively engage teachers in meaningful and relevant activities for their individual contexts, promote peer collaboration and community building, and have a clearly articulated and a common vision for student achievement (Lawless & Pellegrino, 2007).

Technological literacy has quickly become one of the basic skills of teaching (Lawless & Pellegrino, 2007). Alan November, in his article *Why Schools Need to Move Beyond 1:1,* stated, “Corporate high-tech executives observe that too many schools are in “spray and pray” mode with 1:1 computing: “Spray” on the technology, and then “pray” that you get an increase in learning” (February, 2013, p.1). November claims that an increase in student learning cannot be obtained without properly trained professional educators and adding a digital device to the classroom. Without a fundamental change in the culture of teaching and learning, simply adding devices will not lead to significant improvement (November, 2013).

Putting devices in the classroom is only the beginning of the change. As noted above, numerous school districts throughout the nation are in the process of implementing 1:1 technology initiatives. Yet, to varying degrees, many of the implementations are poorly conceptualized when it comes to teacher professional learning and student learning. So, what are the best practices for implementing technology in the classroom? For that answer, the International Society for Technology in Education (ISTE) may help.

Research suggests that the capacity of technology to improve student learning depends more on teacher pedagogy, content knowledge, and instructional goals than the design of the technology itself (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Teacher pedagogy is the practice and theory of the teaching in an academic subject. Next, teacher content knowledge is the facts, concepts, and theories relevant to an academic subject area. Third, is teacher instructional goals or the allowance for determining what content is to be delivered and mastered by students. That is why organizations like ISTE have formed, to help educators understand the importance of strong instructional practice with the addition of devices to improve overall student learning.

ISTE, a non-profit organization designed to assist educators in the implementation of technology in the educational setting, has more than 100,000 members internationally and is the premier repository of information about instructional technology. ISTE assists schools by establishing standards for technology implementation for students, teachers, administrators, and coaches. These standards help guide professional development and implementation within the schools.

ISTE lists six student standards for the infusion of technology into schools. These standards include: creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem solving, and decision-making, digital citizenship, and technology operations and concepts. Each of the standards has five to six specific indicators used to measure student use of technology in the classroom. When measured, these indicators will discern what part of the 1:1 initiative has been done well and what has failed. Used wisely with careful planning ahead of time, these standards can help schools prevent failure in their 1:1 implementation.

ISTE has also provided teacher standards. The teacher standards are organized similarly to the student standards. The five ISTE (2005) Teacher Standards include these: facilitate and inspire student learning and creativity, design and develop digital age learning experience and assessments, model digital age work and learning; promote and model digital citizenship and responsibility and engage in professional growth and leadership. As with student standards, teachers' standards have specific indicators used to inform teacher of desired practices to meet the standards.

Each layer of standards becomes more global as they move from students to teachers to administrators. Due to this global approach, administrator standards include visionary leadership, digital age learning culture, excellence in professional practice, systemic improvement, and digital citizenship. It is the responsibility of the administrator to model and use technology, as well as set the vision in the school.

Lastly, ISTE (2005) includes standards for the technology coach. These standards have similar global responsibilities to the administrator standards. These responsibilities include visionary leadership, teaching, learning, assessments, digital age learning environments, professional development and program advancement, digital citizenship, content knowledge and professional growth.

In addition to standards, ISTE (2005) has also provided publications to assist schools in the use and implementation of 1:1 technology. For example, Bruce Whitehead's (2013) publication *Planning for Technology: A Guide to School Administrators, Technology Coordinators, and Curriculum Planners* has provided models of professional development to assist in the implementation of technology. In his model, there are three parts that should be followed for successful 1:1 implementation: Model 1: Prior to Program Change, Model 2: Subsequent to Program Change, and Model 3: Professional Learning Community (PLC) based.

Model 1: Prior to Program Change is professional development held before the technology is introduced. Teachers have devices before students have devices, and teachers are provided training specific to the use of the device. The idea is to "front load" technical knowledge, pedagogical practice, and content specific training. Teachers are encouraged to experiment with devices, using colleagues to exchange and try new ideas.

Model 2: Subsequent to Program Change is professional development held during the implementation stage of technology. Teachers and students would receive devices at the same time. This model is considered to the most "hands-on" since both teacher and students have devices. There is a sense of urgency with this model on the part of teachers in order meet the need of students. Professional development is at the point of implementation, and the development is ongoing. "The chief advantage of this model the close fit between program change and professional development" (Whitehead, 2013).

Model 3: Professional Learning Community model is the more contemporary approach to professional development. The advantages to this model are the collaboration among colleagues, larger awareness of the initiative, and development of teacher's leadership capacity. Rick DuFour (2004) discussed the three big ideas about Professional Learning Communities, which are ensuring that students learn, a culture of collaboration, and a focus on results. DuFour stated, "Powerful collaboration that characterizes professional learning communities is a systematic process in which teachers work together to analyze and improve their classroom practice," which is the second big idea culture of collaboration (DuFour, p. 6, 2004). Within the 1:1 initiative, this collaborative model can assist teachers in implementation practices. The opportunity to share and problem solve within a community of professionals is critical to the successful implementation of a new model or program. Teachers must have dedicated time to analyze and discuss. They must also be afforded the freedom to experiment and take chances without fear of failure.

Ensuring that students learn means educators in the building must engage in ongoing exploration. Furthermore, educators must continually ask three essential questions. How do students learn? How will educators know each student has learned? How will educators respond when students experience difficulties? These questions are imperative to thriving classrooms with best practices in place, but they are also vital questions when implementing changes in schools, especially technology.

In the context of 1:1 technology, these three questions need to be modified a bit to fit. Changed here, ask the following questions to guide, and then measure, technological changes. First, how can the device enhance the learning potential? Then, how to determine each student used critical thinking and problem solving? Finally, how to assist students who experienced difficulty performing the task? When these questions are discussed and analyzed in a PLC, powerful ideas can form and be utilized.

Aligned Major Themes in Both ISTE-C and Learning Forward Standards

Referenced in the Conceptual Framework are four standards from both ISTE-C and Learning Forward, which closely align technology and general professional development best practices (see Figures 1 and 2). These themes represent leadership; learning design; teaching, learning, and data; and professional development program evaluation and outcomes. The literature surrounding these themes will be presented in this section.

Leadership. Both ISTE-C and Learning Forward Standards identify leadership as a major indicator of a successful initiative. School leadership has the greatest impact on teachers in the classroom and is the key factor for successful achievement of a school's organizational goals (Barber et al. 2010). The growth of research evidence suggesting that principals' matter to school improvement (U.S. Department of Education, 2010) can be found in the statement that every school needs a "great" principal as outlined in its *Blueprint for Reform*. Instructional leadership is one of the most important roles a principal can fulfill to support goals for educational equity and excellence in classrooms (Council of Chief State School Officers, 2014).

Anderson and Dexter (2005) reported, "although technology infrastructure is important, for educational technology to become an integral part of a school, technology leadership is even more necessary" (p. 74). Principals are poorly prepared to lead in a technology-rich environment. Principals must leverage resources beyond formal leadership preparation to develop digital leadership skills (Metcalf & LeFrance, 2013).

Eric Sheninger (2014) declared it is imperative that school leaders develop a vision for the role that technology will play and establish a strategic plan to for implementation. Additionally, leaders must move with vision transferring to action by emulating the behaviors, techniques, and strategies utilized by highly effective technology leaders.

A meta-analysis by Robinson, Lloyd, and Rowe (2008) on leadership and outcomes provided insight to the influence of instructional leadership. The study findings maintained that the closer educational leaders are to the core business of teaching and learning, the more likely they are to have a positive influence on professional learning. The study further stated, “A leader’s involvement in teacher learning provides a deep understanding of the conditions required to make and sustain change (p. 666).”

Learning Design. *Content knowledge and professional* growth from ISTE-C and Learning Forwards *Learning Design* share similar characteristics confirming the importance of professional knowledge and pedagogical practice in the classroom. A growing number of studies in which teams of teachers act as designers of technology-enhanced learning show those same teachers willingly increase technology integration in their classrooms (Cviko et al. 2013). Additionally, knowledge on the subject of technology integration increasingly promotes teachers’ active participation in the design of learning material (Koehler and Mishra, 2005). Current teachers need professional development aimed at technology integration using both the content of their specialization and within the context of the classroom environment (Ruggiero & Mong, 2015).

Teachers need time to master the pedagogical practices as these pertain to student computer literacy skills. Wang, Hsu, Reeves, & Costner's (2014) two-year study revealed year one of implementation teachers managed to change their assignment requirements adding technology and started asking students to use technology to work on their projects. In year two, implementation showed considerable improvement on teachers' effort to develop students' new technology literacy skills. Students received more opportunities to practice how to use technology to evaluate, synthesize, and communicate information through these assignments (Wang et al., 2014).

When teachers embrace a vision for learning, the resulting classroom practices often comprise a form of transformative pedagogy. Adoption of new pedagogical techniques do not happen in vacuum. There are contextual, cognitive, and affective factors that impact it. Promoting best practices in effective pedagogy are at the very core of technology integration. Technology alone cannot improve teaching and learning. Technology must first and foremost be designed to support learning goals (Ertmer & Ottenbreit-Leftwich, 2012).

Teaching, Learning, and Data. The ISTE-C *Teaching, learning, and assessments* standard aligns with Learning Forward's *Data* standard. Both are pedagogically based and use a wide variety of data to determine next steps in learning as well as outcomes in learning. Each provides opportunities for differentiated learning. Within the classroom, an instructor must be able to use technology and connect it to the content pedagogically (Stobaugh & Tassell, 2011). A deficiency in either area can lead to failure. Yet content and pedagogical knowledge are often seen as precursors to successful technology integration (Ruggiero & Mong, 2015). An effective teacher should be able to use technology in a pedagogically sound way (Ertmer et al., 2012).

Ruggiero and Mong in a 2015 study claimed that current teachers need professional development aimed at technology integration using both the content of their specialization and within the context of the classroom environment (Borko, Whitcomb, & Liston, 2009). Simple exposure to technology would not facilitate 21st century learning skills. Students and teachers need to interact with technology in real world settings in order to make it worthwhile in the subject specific activities. This why professional development in critical to teacher learning.

Professional Development, Program Evaluation, and Outcomes.

ISTE-C's *Professional Development and Program Evaluation* and Learning Forwards *Outcomes* are the final standards comparison. Professional development is only as successful as it's outcomes and both ISTE-C and Learning Forward believe a matrix to measure effectiveness and planning for future training is critical.

In 2005 Learning Forward study, Thomas Guskey stated that many good things are done in the name of professional development and conversely there are also bad things. Leaders fail to provide evidence to document the difference professional development makes through some type of evaluation process. Evaluation provides the key to distinguishing between what is good and what is not. As schools develop new professional development, it is important for leaders to consider strategies for providing teachers a consistent method for feedback or evaluation. Feedback and evaluation could include quick surveys or faculty meetings where teachers can freely talk about their perceptions, beliefs, and suggestions related to new programs as well as how they feel about whether the program focus is beneficial allowing for teacher voice (Bernhardt, 2015)

Best Practices for Student Outcomes Using Technology

The single greatest criticism of professional development is the overwhelming prevalence of single-shot, one-day workshops that often make teacher professional development “intellectually superficial, disconnected from deep issues of curriculum and learning, fragmented, and noncumulative” (Ball & Cohen, 1999, pp. 3-4). When teachers receive well-designed professional development, an average of 49 hours spread over six to 12 months, they can increase student achievement by as much as 21 percentile points (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Yoon et al.’s report identified 1,300 studies addressing the effect of teacher professional development on student achievement in three key content areas reading, math, and science. Out of the 1,300 nine met the standards for What Works Clearinghouse. The What Works Clearinghouse was established in 2002 by the U.S. Department of Education's Institute of Education Sciences (IES) to provide educators, policymakers, researchers, and the public with a central and trusted source of scientific evidence of what works in education. These results were confirmed by Shaha’s (2015) multiyear study involving online and on-demand professional development and student learning outcomes. This study combined data from nine previous studies of educational institutions. Each study reflected uniform integrated professional development program with a seminar approach integrated with the same online, on-demand, Internet-delivered professional development for teachers. The Shaha study saw increases in reading and mathematics achievement scores in students. Reading students saw a 19% increase and math students saw a 24% increase from baseline data.

The National Teacher Project declared that quality professional development will yield three levels of results. First, with quality PD, educators will learn new skills because of their participation in the process. Second, teachers will use what they learn to improve teaching and build their capacity. Third, student learning and achievement will increase because teacher use the skills learned in professional development.

Throughout the nation, the number of professional development opportunities for teachers has increased. However, and disturbingly, the understanding about what constitutes quality professional development, what teachers learn from it, or its impact on student outcomes has not substantially increased (Lawless & Pettegrino, 2007). Typically, professional development is measured by teacher activity and experience, instead of student outcomes (Lawless & Pettegrino, 2007).

Mike Schmoker (2015) identified two possible reasons why professional development fails to improve student learning. First, are institutions guaranteeing that all the training provided to teachers is based on best practices and pedagogical research? Second, institutions planning for mastery, by requiring a sustained focus on a severely limited number of practices, with multiple opportunities for frequent monitoring, feedback, and follow-up training?

The National Teacher Project study, entitled *The Mirage*, declared, “Professional development doesn't seem to factor into why some teachers get better at their jobs and others don't” (2015, p.13). Mike Schmoker (2015) claimed that often times, schools fail to be focused on what is important, often “rolling out” multiple initiatives at once. Multiple initiatives often lead to professional development failure.

Elaine Allensworth in the study *School Instructional Program Coherence: Benefits and Challenges* identified three areas that create program coherence. "Program coherence is described as "…a set of interrelated programs for students and staff that are guided by a common framework for curriculum, instruction, assessment, and learning climate and that are pursued over a sustained period" (Allensworth, Bryk, Newmann, & Smith, 2001) . First, program coherence should have common curriculum, strategies, and assessments. Second, staff working conditions must support the implementation framework. Finally, the school allocates resources in advance of implementing the program to avoid a scattered improvement or implementation efforts. The study reports little program coherence in the United States. Additionally, where program coherence exists, positive connections in improving academic achievement occur. According to Allensworth and colleagues,

> This study shows, however, that diverse, multiple short-term innovations within a school will not necessarily link up. To improve student achievement, school staff and the external organizations that work with them should aim toward strengthening instructional program coherence (Allensworth, Bryk, Newmann, & Smith, 2001).

Providing teachers with sustained and targeted professional development in one area of focus provides a better likelihood of successful teacher implementation of the initiative and program coherence. This is specifically true with the integration of technology into classroom culture and teacher pedagogy. Laura Desimone 's study entitled *Improving Impact Studies of Teachers' Professional Development: Toward Better Conceptualizations and Measures* outlines a conceptual framework with five elements (a) content focus, (b) active learning, (c) coherence, (d) duration, and (e) collective participation.

Focus on specific content demonstrates positive outcomes, a focus on subject matter content and how students learn content with increases in teacher knowledge and skills will increase student achievement (Desimone, 2009). Opportunities for teachers to engage in active learning are also related to the effectiveness of professional development (Garet et al., 2001). Active learning versus passive learning where teachers participate in discussion, peer observation, with interactive feedback builds a stronger implementation. As mentioned in the Allensworth study, coherence is critical in the success of the professional development. Coherence is the extent to which teacher learning is consistent with teachers' knowledge and beliefs. "Research shows that intellectual and pedagogical change requires professional development activities to be of sufficient duration, including both span of time over which the activity is spread, and the number of hours spent in the activity" (Cohen & Hill, 2001). Finally, collective participation is a feature that can be accomplished through participation of teachers from the same school, grade, or department. Such arrangements set up potential interaction and discourse, which can be a powerful form of teacher learning (Banilower & Shimkus, 2004). Program coherence and concepts of active learning with sufficient time duration are critical features of successful teacher professional development. Quality professional development that is targeted and sustained create opportunities for impactful student learning and therefore increased student achievement.

Technology rich classrooms are a staple in 21st century learning environments; however, professional development often lags behind the implementation. Technology in the classroom absent of content and pedagogical training is a waste of financial resources and does not boost student achievement. ISTE-T and ISTE-C standards provide scaffolding for districts to appropriately implement technology into classrooms. In additional to ISTE Standards, Learning Forward Professional Development Standards were reviewed in this section. Learning Forward coupled with ISTE-C Standards provides an intense focus on best practices for technology implementation in middle school classrooms. Finally, professional development that focuses on student outcomes can impact learning in the classroom and increase student achievement. Professional development in the technology classroom can lead to a deeper or rigorous technology implementation.

Assessing Technology Implementation

The last major principle of Professional Learning Communities is to focus on results. "Professional learning communities judge their effectiveness on the basis of results" (DuFour, p.4, 2004). Results must be measured with common formative assessments. Within the 1:1 technology initiative, results can be measured in the level of technology implementation. Several technology implementation models currently exist that measure where student learning resides. What types of tools are used to measure both student and teacher implementation of technology?

Three textual frameworks used for measuring technology implementation are SAMR, TIM-O, and TPACK Models. The TPACK and SAMR models are the two most recognized frameworks for effective technology integration. Each model takes different approaches to the technology integration process, and both are grounded in the idea that the technology should elevate and enhance the experience for the learner, not just incorporate a tool for the sake of using technology.

The first model to be reviewed is the SAMR Model. Dr. Ruben Puentedura developed a model to measure levels of technology implementation. His SAMR model is the leading tool used to measure the effective implementation of technology in the classroom (Puentedura, 2013). Alan November (2013) stated the SAMR model “Tames the wild west of technology integration” by identifying technology use. SAMR is an acronym for substitution, augmentation, modification, and redefinition. The goal of the model is to move students from basic technology use: from substitution to redefinition. Substitution is using technology as a substitute for the worksheet, textbook, or multiple-choice assessment. In contrast, the concept of redefinition means to create something new through the use of technology such as writing an eBook or creating a totally paperless classroom.

Common Sense Media a non-profit organization that provides non-bias reviews of technology tools and innovations states SAMR’s popularity is due in part to its similarity to Bloom Taxonomy. Bloom’s Taxonomy developed by Benjamin Bloom established a tool to measure higher level thinking practices in the classroom. Both SAMR and Blooms’ are organized with a ladder starting at simple and moving to complex. Substitution and Augmentation are closely associated with Bloom’s Remember, Understand, and Apply. Moving up the ladder to Modification and Definition that is often coupled with Bloom’s Analyze, Evaluate and Create.

SAMR is clean and simple, which means it can be easily adapted and interpreted in multiple ways. It implies a hierarchy behind technology tool use, providing a goal to shoot for that is quickly explained to an administrator, teacher, or student (Green, 2014). Below is a graphic (Figure 2) that illustrates the SAMR Model.

Figure 4: The SAMR Model

Note: The SAMR Model, http://www.schrockguide.net/uploads/3/9/2/2/392267/5805548.jpg?579

Critics of the SAMR believe it is based on the concept that classrooms start at the traditional level, which may not always be true. Our brains are wired for categorization, and creating structures that crystallize those categories can be extremely useful when beginning a technology implementation. However, critics like Dr. Jeffery Linderoth, from the University of Wisconsin suggest that applying simplistic models like SAMR to large-scale technology integration programs and professional developments only allows for surface level implementation. Linderoth further personally criticized Puentedura since he has neither written a dissertation on SAMR nor has he a university affiliation yet is model is so popular.

Another criticism of SAMR is that the methods of determining a level of technology integration and lack of consideration of the context of the learning environment. Hamilton, Rosenberg, and Akcaoglu (2016) asserted, “The absence of context and the hierarchical nature of

SAMR overlooks the complexity and variety inherit in learning tasks." One framework of technology integration that incorporated the classroom environment directly in its model is the Technology Integration Matrix (TIM), developed by Florida Center for Instructional Technology (FCIT). The TIM is a five-by-five grid matrix, consisting of five classroom environments that include active, collaborative, constructive, authentic, and goal-directed. Additionally, there are five levels of technology integration focused on the pedagogy of the lesson that include entry, adoption, adaptation, infusion, and transformation. The learning environments are not hierarchical; rather, they represent characteristics of meaningful learning contexts for specific lessons (Harmes et al., 2016). More information on TIM will be included in Chapter 3.

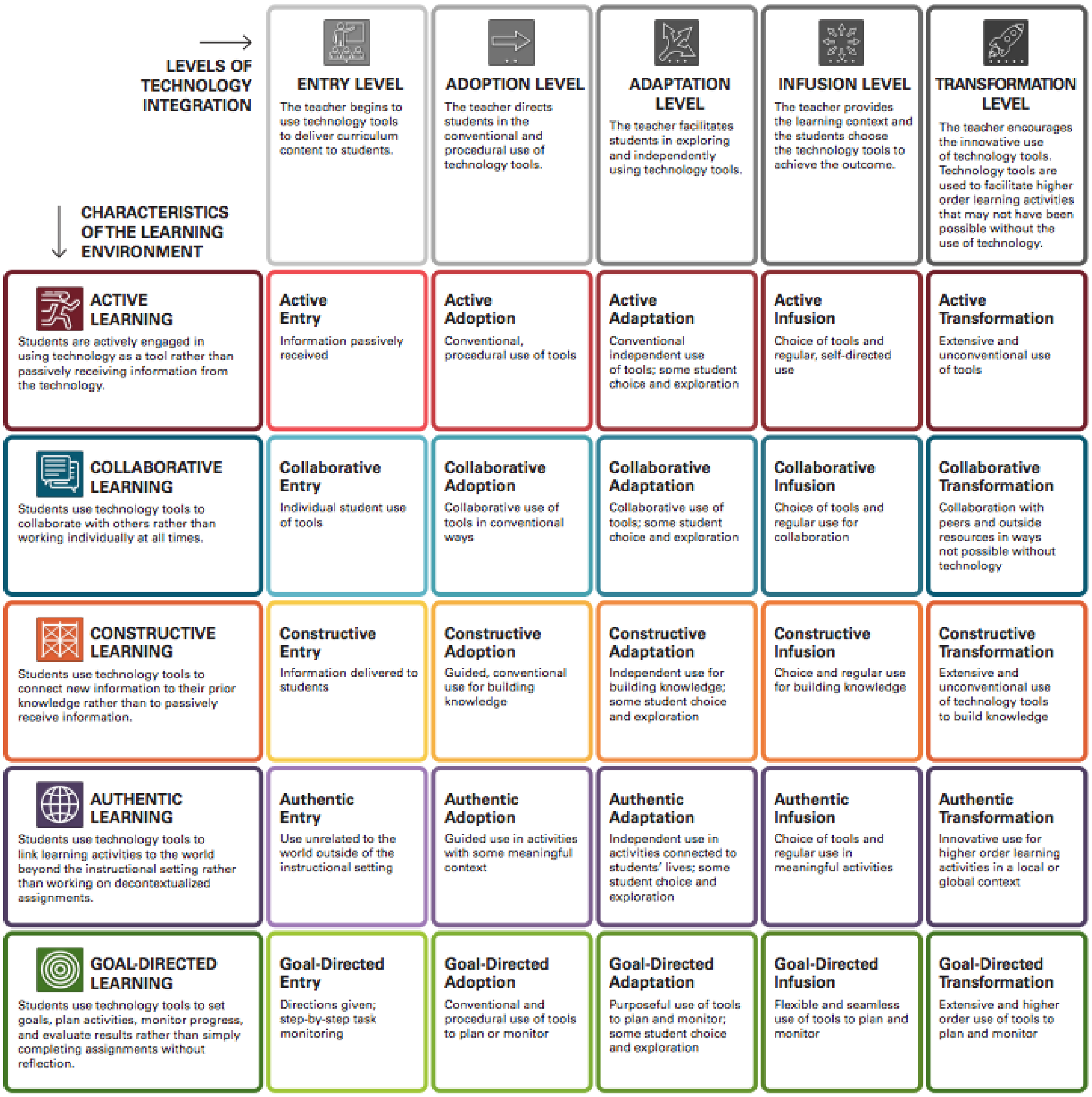

Figure 5: The TIM

Note: The Technology Integration Matrix (TIM) was developed by the Florida Center for Instructional Technology at the University of South Florida. Retrieved from https://fcit.usf.edu/matrix/

The third model is Technological Pedagogical Content Knowledge (TPACK). TPACK is the framework that describes the interplay of three knowledge bases: content, pedagogy, and technology (Mishra & Koehler, 2006). According to the interplay of knowledge, seven types of knowledge are included: content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK). Teachers with TPACK understand how to apply suitable technologies to teach specific content with appropriate pedagogy (Mishra & Koehler 2006).

The TPACK framework is a potentially fruitful model that provides new directions for teachers in integrating technology into instruction (Hewitt, 2008), and describes the knowledge teachers require when designing, implementing, and evaluating curricula and instruction using technology (Niess, 2011). Teachers must develop fluency and cognitive flexibility in each key domain (i.e., TK, PK, and CK) and in the manner in which these domains are interrelated (Koehler & Mishra, 2009). A study by Shih-Hsiung Liu, Center for Teacher Education, National Changhua University of Education, in Changhua, Taiwan demonstrated the basic need for teacher technological knowledge in order to successfully balance the pedagogical and content knowledge. Teachers that significantly improve technological knowledge continually sustain a higher level of technology integration.

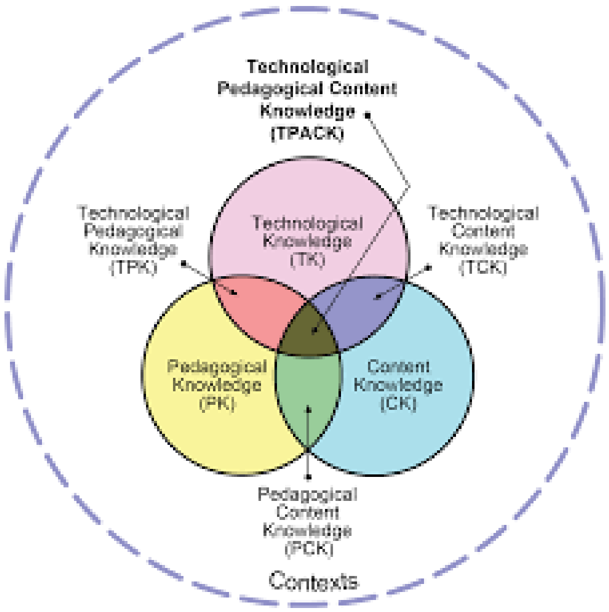

Figure 6: TPACK Model

Note: The TPACK Model, http://www.matt-koehler.com/tpack/wp-content/uploads/new.png

International Society for Technology Education Teacher Standards

Finally, the International Society for Technology in Education (ISTE) developed the ISTE Standards, formerly known as the National Educational Technology Standards (NETS). These standards affect the way students use and learn from technology inside the classroom and out. The standards promote technological advancement and proactive measures on the part of the teacher to encourage and foster involvement in the digital age. Below are the five key aspects of the standards and full standards can be found in appendix A (ISTE, 2005).

The language of the ISTE-Coaching Standards (ISTE-C Standards) establishes best practices for the implementation of technology through coaching. There are five ISTE-C Standards. Standard 1, is visionary leadership that states coaches inspire and participate in developing and implementing a comprehensive vision for technology integration. Standard 2, describes how coaching assists teachers in assessing student learning, differentiated instructional practices, and more importantly rigorous, relevant, and engaging learning experiences. Digital learning environment is the basis of standard 3. Standard 4 is about professional development and program evaluation. With importance of student safety and security, standard 5 states the importance of promotion and modeling of digital citizenship and responsibility. Lastly, standard 6 demonstrates the importance of content knowledge and professional growth. All standards include five to six specific indicators to assist with implementation.

Summary

This chapter reviews the literature as it pertains to the history of 1:1 technology, selection of devices, professional development in the context of student learning, and effective professional development/implementation models in the 1:1 technology environment. Often opportunity for change in the 1:1 environment is missed. A low-level use of technology in the classroom often results in devices used simply as digital workbooks. However, 1:1 initiatives, with effective instructional support, have the ability to leverage extraordinary learning opportunities.

1:1 initiatives have many barriers that include teacher acceptance, poor implementation practices, lack of professional development, cost, and sustainability. However, building level leadership and strong visioning can overcome barriers with successful implementation strategies and long term sustainable professional development. The review of the literature demonstrated that sustained and targeted professional development yields the best results for student learning and teacher technology integration. It appears that the timeline for deploying professional development could be as significant as the content of professional development. There are two opportunities, or a combination of two ideas, for professional development relative to the rollout of technology: pre-implementation and concurrent to implementation. Pre-implementation, for this study, is considered allowing teachers ample time with devices prior to student rollout and professional development specifically on technological knowledge of devices before student rollout. Pre-implementation is also considered target professional development for rollouts, which includes device pilots in content areas or grade levels. In contrast, with concurrent to implementation methods, where teachers may get devices at the same time as students, learning is combination self-directed and job embedded, and additional learning is gained by being a part of professional learning communities. Since the review of literature yielded no research in this area, a study filling this void could be of value in the future.

Focused professional development based on International Society for Technology in Education Standards for Teachers can improve the implementation practices in the 1:1 environment. Professional development should include best practices and models for implementation, such as the SAMR or TPACK models. TPACK establishes a model for district technology implementation that ensures a balance in the technological, pedagogical, and contextual knowledge. Similarly, SAMR can measure implementation with a classroom technology in simple highly visual representation that is easy for both teacher and student. Both of the conceptual frameworks of SAMR and TPACK can provide a basic district level model for technology implementation; however, instructional practices are complex and multifaceted. This makes ISTE-T standards a more targeted and measurable tool for this study. Chapter 3 of this study will address the research methods use to respond to the gap in the literature.

CHAPTER THREE

RESEARCH METHODS

This chapter describes the quantitative study with qualitative aspects design used to examine effective professional development and the level of implementation of 1:1 technology integration in the middle school classroom. The chapter begins with the rationale for the selection of a quantitative study with qualitative aspects approach followed by details of the quantitative and qualitative phases of the study. The chapter is organized into the following sections: (1) purpose of the study, (2) research questions, (3) research design, (4) population and sample, (5) instrumentation, (7) data collection procedures, (8) data analysis, and (9) limitations of the study.

Purpose of the Study

The purpose of this study is to identify the relationship between effective professional development and the level of implementation of 1:1 technology integration in the middle school classroom. The effectiveness of professional development and instructional practices will be measured by teacher observations, a survey, and focus groups using the Technology Integration Matrix (TIM-O) and Technology Uses and Perceptions Survey (TUPS). The independent variables include: initial comfort level with technology, gender, age, years of experience, content area, and educational setting (general education/special education/honors). Further, the dependent variables include the measurement of both technology integration measured by Learning Forward Standards and ISTE-Coaching Standards.

Research Questions

The research questions that guided this study were:

R_1 Based on the perceptions of middle school teachers, what practices motivated the deepest level of technology implementation (i.e. formal professional development pre-implementation or concurrent to implementation, digital leadership, teacher initiative, or school culture)?

R_2 How do stakeholders perceive changes in instructional practices have occurred since the technology implementation based on the ISTE-Coaching Standards?

R_3 When comparing two schools, one using pre-implementation practices and the other concurrent practices, which school has the deepest level of implementation measured by ISTE-Coaching Standards?

R_4 What are the differences in ISTEP+ and NWEA assessment data, comparing pre- and post-implementation data of 1:1 technology in both districts?

Research Design

This study uses quantitative with qualitative aspects approach as its research design short of fully mixed method. According to Tashokkori (2009), parallel mixed methods design permits researchers to triangulate results from the separate qualitative and quantitative components of research to confirm or cross-validate findings from a single study (Creswell, Plano-Clark, Gutmann & Hanson 2003). This study does use more quantitively research with some as aspects of qualitative research. With a mix of close-ended survey questions and open-ended interviews/observations, quantitative and qualitative research can provide more divergent views than traditional qualitative and quantitative research alone (Tashokkori & Teddlie, 2009). With data from a mixed method approach, this study can analyze specific 1:1 technology implementation and define what practices lead to the deepest technology integration. This study will use closed ended quantitative components through survey and classroom observation. Additionally, the study will use open-ended qualitative components in the form of teacher focus groups. Data for the two components will be separately collected, analyzed, and then merged to understand where they converge and diverge.

Sample

The sample for this study consisted of 184 middle school teachers in two districts throughout Indiana who are implementing 1:1 technology initiatives. The population of the survey consisted of 184 teachers across two districts. Twenty core content teachers were randomly selected for classroom observations using TIM-O in each school district. A spreadsheet containing the names of content area teachers was developed and run through randomizing software. Selection came from the order after randomization was complete. Criteria and norms were set for teachers' exclusion in the observation, which included teacher absence, student testing, and/or class field trips.

Setting and Participant Demographics

Wagner Middle School[1] houses students in grades 6-8 within the district of 7,000 students in the central part of the state (see Table 3.1 for demographic comparison). The Wagner Middle School attendance area community includes urban, suburban, and rural areas. The school has an enrollment of 1,396 students.

Wagner Middle School is the only middle school in a district that once sustained 3 middle schools, 3 high schools and twenty elementary schools. At its peak, enrollment the district was over 20,000 students. Through the loss of major auto manufacturing jobs, this district now enrolls approximately 7,000 students giving the community the distinction of being part of the midwestern rest belt.

Since the primary employer in the community was the auto industry, the school district adopted many of the practices of a robust United Auto Worker's (UAW) contract on both the certified and non-certified ranks. Administration was not permitted to effectively evaluate staff with many decisions made based on seniority of staff versus teaching excellence. As a result, most schools persisted in a toxic environment where management and certified staff were constantly at odds.

Through changes in state legislation, many of the aspects of a UAW-like contract were made illegal. However, before the laws could be enacted, an 8-year contract was signed and

[1] For confidentiality purposes a pseudonym was used.

ratified to legally continue many of the protections and privileges of the old contract until December 31, 2018.

Mozart Middle School is in a large urban/suburban school district of approximately 12,267 students in central part of the state. According to 2015, Indiana Department of Education data, Mozart Middle School has an enrollment of 619 students and houses students in grades 5-8.

Within the student population, both schools are predominantly White. Wagner Middle School has a higher percentage of Black students and Mozart Middle School has a higher percentage of Hispanic students. Wagner Middle School had a higher percentage of students qualify for free and reduced lunch and for special education services. Both Mozart Middle School and Wagner Middle School shared the same percentage of English Language Learners. Wagner Middle School has a higher attendance rate than Mozart. Academically, Mozart Middle Schools pass both math and English language arts as measured by the Indiana State Test of Educational Progress (ISTEP) in 2015 at a higher rate than Wagner Middle School (Indiana Department of Education COMPASS, 2016).

Wagner Middle School has 117 certified staff, which includes four administrators. Mozart Middle School has 67 certified staff including two administrators. The ethnic breakdown of the staff in both schools was predominantly white. Mozart Middle School had more black teachers than Wagner Middle School. Wagner Middle School had a higher percentage of Hispanic and multiracial staff. In years of experience, Wagner Middle School has a more veteran staff than Mozart Middle School.

Warner Middle School received an Indiana Department of Education grant in 2014 and 2015 to implement 1:1 technology. In 2014, 60 students and 2 teachers were part of 1:1 pilot program for the entire 6th grade in the 2015-2016 school year. Before grade level implementation, teachers participated in focused and specific training on how to use devices and navigate current curriculum using digital tools. After another small pilot in grades seven and eight grade in the 2015-2016 school year, full implementation and subsequent training occurred for teachers in those grade levels in 2016-2017. As such, Warner Middle School is in its first year of full 1:1 implementation.

In 2012, Mozart Middle School benefited from a United States Department of Education Race to the Top grant that awarded over 28 million dollars to the district to implement personalized learning and 1:1 technology integration. In 2014, the district implemented a complete 1:1 implementation in grades K-12. At this time, Mozart Middle School is in the third year of implementation.

Table 1:

Comparison Data for Wagner and Mozart

	Wagner	Mozart	State
School Enrollment	1,396	619	254,856
District Enrollment	6,954	12,267	1,133,380
Free and Reduced Lunch	82%	70%	62%
Ethnic Background	57% White 23% Black 11% Multiracial 7% Hispanic 1% Asian	44% White 35% Black 6% Multiracial 14% Hispanic 1% Asian	69% White 12% Black 5% Multiracial 11% Hispanic 3% Asian
Special Education	22%	16%	
English Language Learner	4%	4%	
Attendance Rate	95%	96%	95.8%
Number of Staff	117	67	
Staff Ethnic Background	87% White 8% Black 3% Hispanic 2% Multiracial 1% Asian	88% White 12% Black 0% Hispanic 0% Multiracial 0% Asian	
Staff Years of Experience	25% 0-5 Years 11% 6-10 Years 18% 11-15 Years 12% 16-20 Years 33% More than 20 Years	23% 0-5 Years 31% 6-10 Years 15% 11-15 Years 18% 16-20 Years 12% More than 20 Years	
ISTEP Pass Rate Both ELA and Math	29% Pass Rate	41% Pass Rate	49% Pass Rate
1:1 Technology Implementation	Year 2	Year 3	

Table 1 compares the two middle school buildings in this study and the State of Indiana. Enrollment in the two middle school buildings and the individual districts is quite different. Wagner Middle School has an enrollment of approximately 1,400 students while Mozart only enrolls approximately 600. At the district level the enrollment differences flip, with Wagner at approximately 7,000 students compared to Mozart at 12,000. For obvious reasons, staffing each of the buildings is different, with Wagner at 117 staff compared to 67 at Mozart. When comparing years of experience, Mozart Middle School appears to have younger staff than that of Wagner. Implementation of 1:1 technology is slightly different with Mozart in year three of implementation and Wagner in year two. Demographically, the buildings are similar when comparing ethnic background and free and reduced lunch rates for students enrolled. Both buildings have similar student attendance rates. Additionally, the buildings share a similar ethnic background among staff. Both districts perform under state averages in ISTEP pass rate. Both districts also have a higher free and reduced lunch rate and percentage of Black and Hispanic students then the state average.

Instrumentation

For this study, the instruments eluded a combination of a survey entitled *Technology Uses and Perceptions Survey (TUPS)* and classroom observation entitled *Technology Integration Matrix Observation (TIM-O).*

Table 2:

Comparison of ISTE-C Standards and TUPS/TIM-O Matrix

ISTE-C Standards	**TUPS/TIM-O Matrix**
Visionary Leadership	Technology Access and Support, Preparation for Technology Use
Teaching, Learning, and Assessments	Technology Integration, TIM-O Matrix
Digital Age Learning Environments	Technology Access and Support, TIM-O Matrix
Professional Development and Program Evaluation	Teacher Perceptions of Professional Development, Preparation for Technology Use
Content Knowledge and Professional Development	Confident and Comfort Using Technology, Teacher Perceptions of Professional Development

Table 2 compares ISTE-C Standards to the instruments used in the study the TUPS and TIM-O Matrix. The table demonstrates an alignment of TUPS and TIM-O Matrix in six of the seven ISTE-C standards. The TUPS and TIM-O did not measure digital citizenship. The close alignment of the both ISTE-C and TUPS, as well as TIM-O, reinforces an appropriate use of the instrument for this study.

TUPS Technology Uses and Perceptions Survey

First, teachers were surveyed with TUPS to explore the effects professional development pre-implementation and concurrent to implementation on the technology integration project in middle school classrooms. The survey includes 200 items in seven categories in the area of technology access and support, preparation for technology use, perceptions of technology use, confidence and comfort with technology, technology integration, teacher and student use of technology, and technology skills and usefulness.

TIM-O Teacher Observation Tool

The teacher observation tool TIM-O (Appendix C) provides feedback on a continuum of five levels of technology integration that include *entry*, *adoption*, *adaption*, *infusion*, and *transformation*. *Entry* level is defined as "Using technology to deliver curriculum content to students.[2]" The *adoption* level occurs when "directing students in the conventional and procedural use of technology." If students are exploring and independently using technology as the teacher facilitates, then TIM-O calls that the *adaption* level. Next, the *infusion* level indicates that "The teacher provides the learning content and the students choose the technology." Finally, *Transformation* is defined as "Encouraging the innovation use of technology tools. Technology tools are used to facilitate higher order learning activities that may not have been possible without the use of technology."

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[2] From TIM-O Manual http://fcit.usf.edu/matrix

The Technology Integration Matrix Observation (TIM-O) is a Web based tool that can be used to evaluate the level of technology integration within a specific lesson. It uses questions to guide the observer to identify the technology integration level based on the TIM teacher, student, and instructional setting descriptors. As described by FCIT, the use of skip-logic questions based on observable elements during the lesson brings consistent identification of a TIM level, regardless of the observer's familiarity with the TIM (Florida Center for Instructional Technology, 2017).

The TIM-O observation tool also measures the level of professional development by describing the learning environment that included *active*, *collaborative*, *constructive, authentic*, and *goal oriented*. In an *active* classroom environment, students are engaged in using technology as a tool rather than passively receiving information from the technology. *Collaborative* environment includes, student use technology tools to collaborate with others rather than working individually at all times. Next, *constructive* environments are where students use technology tools to connect new information to their prior knowledge rather than to passively receive information. *Authentic* environments are where students use tools link learning activities to the world beyond the instructional setting rather than working on decontextualized assignments. Finally, in *goal-oriented* environments students use technology tools to set goals, plan activities, monitor progress, and evaluate results rather than simply completing assignments without reflection.

The TIM-O Matrix contains teacher descriptors. The teacher descriptors are *entry*, *adoption*, *adaption*, *infusion*, and *transformation*. Below is the complete explanation of each descriptor as it relates to technology integration.

Teacher Active Learning Descriptors:

Entry. At the *Entry* level, typically the teacher uses technology to deliver curriculum content to students. *Entry* level activities may include listening to or watching content delivered through technology or working on activities designed to build fluency with basic facts or skills, such as drill-and-practice exercises. In a lesson that includes technology use at the *Entry* level, the students may not have direct access to the technology. Decisions about how and when to use technology tools as well as which tools to use are made by the teacher.

Adoption. At the *Adoption* level, technology tools are used in conventional ways. The teacher makes decisions about which technology tool to use and when and how to use it. Students exposure to individual technology tools may be limited to single types of tasks that involve a procedural understanding.

Adaption. At the *Adaptation* level, the teacher incorporates technology tools as an integral part of the lesson. While the teacher makes most decisions about technology use, the teacher guides the students in the independent use of technology tools. Students have a greater familiarity with the use of technology tools and have a more conceptual understanding of the tools than students at the *Adoption* level. They are able to work without direct procedural instruction from the teacher and begin to explore different ways of using the technology tools.

Infusion. At the *Infusion* level, a range of different technology tools are integrated flexibly and seamlessly into teaching and learning. Technology is available in sufficient quantities to meet the needs of all students. Students are able to make informed decisions about when and how to use different tools. The instructional focus is on student learning and not on the technology tools themselves. For this reason, *Infusion* level work typically occurs after teachers and students have experience with a particular technology tool. The teacher guides students to make decisions about when and how to use technology.

Transformation. At the *Transformation* level, students use technology tools flexibly to achieve specific learning outcomes. The students have a conceptual understanding of the tools coupled with extensive practical knowledge about their use. Students apply that understanding and knowledge, and students may extend the use of technology tools. They are encouraged to use technology tools in unconventional ways and are self-directed in combining the use of various tools. The teacher serves as a guide, mentor, and model in the use of technology. At this level, technology tools are often used to facilitate higher order learning activities that would not otherwise have been possible or would have been difficult to accomplish without the use of technology.

The TIM-O Matrix also contains student descriptors. The descriptors are *active*, *collaborative, constructive, authentic,* and *goal oriented*. Below is the complete explanation of each student descriptor as it relates to technology integration in the classroom.

Student Indicators:

Active. The *Active* characteristic makes the distinction between lessons in which students passively receive information and lessons in which students discover, process, and apply their learning. Student engagement is a key component of active learning.

Collaborative. The *Collaborative* characteristic describes the degree to which technology is used to facilitate, enable, or enhance students' opportunities to work with peers and outside experts. This characteristic considers the use of conventional collaborative technology tools as well as other kinds of technology tools that assist students working with others.

Constructive. The *Constructive* characteristic describes learner-centered instruction that allows students to use technology tools to connect new information to their prior knowledge. This characteristic is concerned with the flexible use of technology to build knowledge in the modality that is most effective for each student.

Authentic. The *Authentic* characteristic involves using technology to link learning activities to the world beyond the instructional setting. This characteristic focuses on the extent to which technology is used to place learning into a meaningful context, increase its relevance to the learner, and tap into students' intrinsic motivation.

Goal Oriented. The *Goal-Directed* characteristic describes the ways in which technology is used to set goals, plan activities, monitor progress, and evaluate results. This characteristic focuses on the extent to which technology facilitates, enables, or supports meaningful reflection and metacognition.

In developing the TIM, experts evaluated each phase through field testing using purposeful sampling (Allsopp et al., 2007). The data included a survey of experts in instructional technology (IT) solicited in August 2005; feedback from the Florida Council of Instructional Technology Leaders (FCITL), professors of IT, and school district IT directors in September 2005; feedback from K-12 and higher education experts and professors of IT in the areas of childhood education, reading, special education, public school IT coordinators, media specialists, and public school teachers between September 2005 and June 2006; and reviewed by the Florida Department of Education Matrix Advisory Meeting at the Florida Educational Technology

Conference (FETC) in March 2006 and January 2007. The comments and feedback from reviewers were coded and were used to revise the TIM (Allsopp et al., 2007).

Barbour (2014) investigated the TIM in relation to student engagement in technology centered classes and non-technology centered classes. He found that there was a positive correlation between technology integration, as measured with the TIM, and student engagement, as measured by the Class Map Survey instrument, with a Pearson coefficient of .69 for the technology centered courses and .67 for the non-technology centered courses.

TUPS Technology Uses and Perceptions Survey

The Technology Uses and Perceptions Survey **(**TUPS) is a 200-question (Appendix B) survey covering seven areas of perceptions and technology use in the classroom. In addition to demographic information, the seven areas included are: *technology access* and *support*, *preparation for technology use, perceptions of technology use, confidence and comfort using technology, technology integration, teacher and student use of technology*, and *technology skills and usefulness.*

The TUPS examines what teachers believe about the role of technology in the classroom, as well as their comfort and confidence with technology in general, with pedagogy of technology, with a variety of different specific technologies, and it also asks about the frequency that they use those technologies and the frequency with which their students use those technologies (Florida Center for Instructional Technology, https://fcit.usf.edu/matrix/evaluation-tools/tups/ retrieved 6/12/2017).

The Florida Center for Instructional Technology website reports most respondents can complete the TUPS in approximately 30 minutes or less. Additionally, respondents can complete the TUPS in sections and the option to save survey progress is available throughout. Within each section, each question stem provides a user rating scale. For example, the *Technology Skills and Usefulness* section includes two different perspectives, the teacher themselves and teacher perceptions of student skills and usefulness. These levels are provided as choices on the scale: 1-none, 2-very low, 3-low, 4-moderate, 5-high, and 6-very high. Other scales used on the survey included frequency (not at all to multiple times per day), agreement (strongly disagree to strongly agree), and extent (not at all to entirely).

The TUPS was developed through a process of determining the domains to be included, item construction, pilot testing with graduate students, and large-scale field testing (Hogarty et al., 2003). It was then validated in both paper and web-based formats. Hogarty et al. (2003) used common factor analysis to determine if each section measured only one dimension and calculated Cronbach's Alpha on each factor score to investigate reliability of the scores. They found that each section had levels of reliability between .74 to .92, which indicated a strong level of reliability (Field, 2013).

Barron et al. (2003) further used the four domains of the original perception survey to study teachers' use of technology in the classroom as related to the International Society of Technology Education (ISTE) guidelines. The four domains chosen were: *technology integration; support; preparation, confidence, and comfort;* and *attitude toward computer use*. This instrument was reviewed by experts in technology and measurement, pilot tested, followed by applying minor revisions before distributing to the teachers in the study in paper or Web based format (Barron et al., 2003). They found the reliability of these domains using Cronbach's Alpha as .89 for the paper version and .87 for the Web version, which also indicated strong reliability (Field, 2013).

Data Collection

Data collection for this study had three components that include: a survey (TUPS), classroom observations (TIM-O), and focus groups. These data were gathered in phases. Phase 1 included a survey emailed to all staff of both middle school buildings. Both staffs had three weeks to complete the survey questionnaire. Completed survey data was then exported to SPSS software for analysis. Phase 2 included teacher observations. I completed 10 observations per middle school building of core content teachers (English, Math, Social Studies, and Science) using the TIM-O observational tool. Results from completed observations were exported to SPSS software for analysis. After analyzing data from both survey and observation data, I developed additional questions for focus groups to provide deeper understanding of the quantitative data. I randomly selected focus groups teams from staff in both middle schools. All focus group meetings were recorded and transcribed in order to capture important conversations.

Quantitative Instruments

First, teachers received surveys via a link to email. Teachers then had a three-week period to complete their surveys. Weekly reminder emails were sent for maximum participation and completion. All surveys were anonymous. In addition to technology use and perceptions, demographic data collected included the teachers' gender, years of teaching experience, subject area(s) taught, years of using instructional technology, and grade levels taught. This demographic data was correlated to the TUPS results and (TIM-O) observational data to determine the extent that teacher demographics relate to technology perceptions and technology integration level. In addition, a summary of teacher TIM levels, responses of teachers' perceptions of technology integration from the TUPS, and types of professional development they find most beneficial was reported.

The second phase of data collection came from classroom observations (TIM-O). The observation tool was designed to gather evidence beyond the survey on some of the ISTE-C standards that are observable. Observed classrooms and teachers were randomly selected from the sample of teacher volunteers. Volunteers were selected by distribution of a Google Form (Appendix E). All volunteer teacher names were entered into a database and then uploaded into a randomizer. Ten teachers plus three alternates from each school were randomly selected for classroom observation. Classroom observations were only five minutes in length and in core content area classrooms only.

Qualitative Instrument: Guiding Focus Group Questions

The final phase of data collection was conducted through focus groups. Focus group respondents were selected by grade level teams in grades 6, 7, and 8, from the sample of 184 teachers. Focus groups included teachers from multiple core content subject areas and years of teaching experience. Focus groups did not exceed six teachers and were conducted for approximately 45 minutes.

Focus groups used a semi-structured format (Lederman, 1990). The semi-structured questions were based on the research questions and findings presented from the quantitative data. Semi-structured interviews provided a means to probe deeper and add insight, which is not available from the statistical data. The focus group questions were designed to guide the discussion without hindering the educators' input and reflection. The focus group protocol is provided in Appendix D.

Data Analysis

Data for this study will involve both quantitative and qualitative analysis. This section describes the types of data analysis used for research instrument.

Quantitative Analysis

To analyze data attained from the teacher survey (TIM-O) and teacher observations (TUPS), results were downloaded into IBM's Statistical Package for the Social Sciences (SPSS) for statistical analysis and predictive analytics. Through the use of descriptive statistics, SPSS described the sample and identified trends in the data as it relates to technology integration through the lens of gender, age, years of teaching experience, and subject area. In addition, the study analyzed which professional development or training resulted in the deepest level of implementation, whether the training was formal professional development, pre-implementation, or concurrent to implementation, digital leadership, teacher initiative, or school culture. Specific measures used to analyze the level of technology integration data included traditional descriptive statistics that include means, standard deviations, and frequencies to present the data in a manageable form. Thus, descriptive statistics can provide a concise picture of the data (Trochim, 2006). Means and standard deviations were computed for each group: gender, age, years of experience, initial comfort level with technology, and content area taught.

Beyond descriptive statistics, inferential statistics (i.e. ANOVA, t-test and chi square) were used. The data were analyzed using t-tests to determine if a significant difference existed between the means of any factors, such as gender, age, years of experience, initial comfort level with technology and content area taught. To ascertain if any type of professional development appeared to have more influence in one group than another, chi square t-tests were conducted to compare group frequencies. An analysis of variance (ANOVA) was run to conclude if a significant difference exists between teacher levels of technology implementation and the types of professional development exposure. Prior to running test, the equality of variance between groups was examined using Levene's Test to confirm homogeneity of variances.

Qualitative Analysis

With the permission of the focus group participants, each group discussion was recorded for analysis and coding. Participants signed a consent form and were reminded that discussion would be recorded for later coding. The recordings were stored on a secured computer.

At the onset of the focus group discussion, the data and the statistical analysis from phase 1 and 2 of the quantitative study were shared with the group prior to discussion. Various statistical analysis was provided along with the data. Interpretation of the results were not provided. The participants were asked if further explanation of the study data or statistics was necessary.

Next, each focus group was asked identical open-ended questions to guide discussion. The questions focused on aspects of the research questions not fully answered through quantitative data. Clarifying, probing, or inquiry questions were used to better understand focus group thinking or broaden thinking based on the participant's comment.

For this research, Initial Coding was utilized due to the appropriateness for almost any study and the beginning qualitative researcher's skill level. Initial coding requires time to digest, provides analytical leads, is cyclic in nature, and may alert the researcher to more data needs to support results (Saldana, 2009). The steps employed for the initial coding were:

(1) Pre-coding responses that were high frequency in the initial review

(a) During focus group conversation, initial notes were taken based on keywords that stood out from the research questions that were categorized.

(b) To better understand the dialogue during focus groups and audio recording was made.

(2) Decoding and encoding for the real meaning

(a) Each focus group's audio recording was reviewed, categorized, and labeled with content descriptors, data examples, and the role of the speaker (Saldana, 2009).

(b) A code ledger was created, and similar codes were clustered. The ledger columns included topics, unique topics, and leftovers (Roberts, 2010).

(3) Analysis of the codes for meaning

(a) Patterns and unique insights among focus group respondents

(b) Patterns with the quantitative results from the data

(c) Frequency of an expression by focus groups members

(d) Expressions that may support research findings or provide potential research questions for further study.

An important aspect to recall with coding is that it is done through the eyes of the researcher with the goal of organizing evidence into methodical categories and linking ideas together, specifically for this research to add richer meanings to the quantitative results.

Limitations

A limitation of the study was the small sample size, with only two districts in the study. Within the two districts, 184 teachers were asked to participate in the survey. In addition, 20-30 of those teachers participated in classroom observations and focus groups.

Using my current district as one of the districts studied was a limitation to this study. I am currently employed as the assistant superintendent responsible for technology integration. Using the researcher's own district could create bias in how the study was initiated and then concluded. To limit bias, all surveys were anonymous; plus, observation and focus group participants were randomly selected. Additionally, the observation tool was field tested by a team to develop clear criteria for the ratings used.

Permission was obtained by individual teachers for classroom observations. Teachers who did not volunteer may be reluctant to implement technology. Reluctance for teachers to participate may skew results of this study as results could be biased by the type of teacher more likely to volunteer for a research study. That teacher is probably more confident about his or her level of implementation.

Summary

This study used quantitative and qualitative tools to answer the four research questions in this study. The research design used a combination of teacher surveys (TUPS), classroom observations (TIM), and teacher focus groups. The setting and participants in this study were classroom teachers in two middle schools in two different districts in the state of Indiana. Data collection procedures included surveying 184 teachers between the two middle schools. Approximately 10 teachers in each middle school were randomly selected to participate in classroom observations. One core content area team per grade level also participated in focus groups. Limitations to the study included small sample numbers, since only two districts were used, and a potential bias, since the researcher's district was used. Chapter 4 will discuss the results of the research study.

CHAPTER FOUR

RESULTS

This chapter describes the results of my study by outlining the analysis of the research questions regarding the relationship between professional development and the implementation of 1:1 technology in the middle school classroom. This quantitative study included a minor qualitative element, which was integrated for the purpose of triangulating data through quantitative and qualitative measures. A comparison of two school districts with similar demographics, but distinctly different 1:1 technology rollouts, will be analyzed and presented in this chapter. First, I'll review my purpose of the study and the research questions. Then I'll present my data analysis, including information regarding reliability and the results of the descriptive and inferential statistical analysis.

Purpose of the Study

The purpose of this study is to identify the relationship between effective professional development and the level of implementation of 1:1 technology integration in the middle school classroom. The effectiveness of professional development and instructional practices will be measured by teacher observations, survey, and focus groups using the Technology Integration Matrix (TIM-O) and Technology Uses and Perceptions Survey (TUPS). The independent variables include these: initial comfort level with technology, gender, age, years of experience, content area, and educational setting (general education/special education/honors). Further, the dependent variables include the measurement of both technology integration measured by Learning Forward and ISTE-Coaching Standards.

Research Questions

The research questions that guided this study were:

R_1 Based on the perceptions of middle school teachers, what practices motivated the deepest level of technology implementation (i.e. formal professional development pre-implementation or concurrent to implementation, digital leadership, teacher initiative, or school culture)?

R_2 How do stakeholders perceive changes in instructional practices have occurred since the technology implementation based on the ISTE-Coaching Standards?

R_3 When comparing two schools, one using pre-implementation practices and the other concurrent practices, which school has the deepest level of implementation measured by ISTE-Coaching Standards?

R_4 What are the differences in ISTEP+ and NWEA assessment data, comparing pre- and post-implementation data of 1:1 technology in both districts?

Reliability Statistics

Reliability in statistics is the overall consistency of a measure. A measure is considered to have high reliability if it produces similar results under the same conditions. Highly reliable scores are considered accurate, reproducible, and consistent from one test to another. Meaning, if the testing process were repeated with a different group of respondents, the same results would be obtained. Reliability coefficients, with values ranging between significant error (0.00) to no error (1.00) are used to indicate the amount of error between variables.

For a two-week period in the fall of 2017, teachers at both Wagner and Mozart Middle School completed the Technology Use and Preferences Survey using Qualtrics. The survey included 73 questions that were a combination of short answer, multiple choice, and Likert scales. Between both schools, 60 teachers completed the questionnaire.

Table 3 displays reliability statistics for the TUPS instrument using Cronbach's alpha. Cronbach's alpha is a measure of internal consistency, which determines how well the items on a test measure the same construct or idea. A Cronbach's alpha of .9 or higher is considered to have an excellent internal consistency, .8 to .9 is considered good, with .8 to .7 acceptable, and .7 to .6 questionable.

The highest internal consistency from TUPS constructs was *Technology Access and Support* (*a*=.906). Three constructs were considered to have good internal consistency. *Perceptions of Technology Use* (*a*=.609) and *Perceptions of Professional Development* (*a*=.634) were found to be questionable internal consistency. The constructs of *technology access and support, perception of technology use, confidence and comfort using technology,* and *technology integration* resulted in Cronbach's alpha measures as excellent or good. Two areas, *preparation for technology use* and *teacher perceptions of professional development,* were considered questionable. These two categories might have fallen in the questionable category due to the few number of survey questions in each of those two constructs. All other constructs had between six and ten questions; however, the two questionable constructs only had four each.

Table 3:

Reliability Statistics for TUPS

Survey Topics	Cronbach's Alpha
Technology Access and Support	0.906
Preparation for Technology Use	0.609
Perception of Technology Use	0.847
Confidence and Comfort Using Technology	0.897
Technology Integration	0.895
Teacher Perceptions of Professional Development	0.634

Descriptive Statistics

The overall response rate for TUPS was 45% of those contacted, or 60 out of 134 teachers responding overall. Wagner had 41%, while Mozart had nearly 56%. Since the Mozart sampling numbers are smaller than Wagner, the higher percentage of participation should yield sufficient data to enable a robust analysis.

Demographic data from the samples at Mozart and Wagner school districts are displayed in Table 4. In both districts, teachers represented in the tables completed the Technology Use and Perceptions Survey (TUPS). The tables are divided into seven categories representing the entire sample and the sample by district in both raw numbers and percentages to assist in determining similarities and differences. Both schools had similar percentages of males and females within the sample. However, more females responded versus males to nearly a three to one ratio in both the combined sample and in each of the district results. In both districts the highest percentage of respondents taught in the range of 6-20 years. The highest percentage of respondents by years taught within the subgroup in Wagner was 16-20 years and in Mozart 6-10 years of teaching experience. At Wagner and Mozart, the highest percentage of respondents' subject area taught was English. The lowest percentage of respondents for both schools was in the area of Family and Consumer Science (FACS) where no teachers responded. Wagner had a high percentage of respondents in the category of *other*. These respondents were mostly instructional coaches and teachers of special needs students. In both school districts, respondents were primarily White.

Table 4:

Demographic Data from The Study Sample

		Overall Sample	Wagner Sample	Mozart Sample	Overall %	Wagner %	Mozart %
Gender	Female	44	30	14	73%	75%	70%
	Male	16	10	6	27%	25%	30%
Years of Experience	0-5	12	8	4	20%	20%	20%
	6-10	11	4	7	18%	10%	35%
	11-15	6	4	2	10%	10%	10%
	16-20	14	10	4	23%	25%	20%
	21-25	4	3	1	7%	8%	5%
	26-30	3	2	1	5%	5%	5%
	31 +	10	9	1	17%	23%	5%
Subject Area Taught	English	17	9	8	28%	23%	40%
	Math	10	5	5	17%	13%	25%
	Science	7	6	1	12%	15%	5%
	S. Studies	4	3	1	7%	8%	5%
	W. Lang.	3	2	1	5%	5%	5%
	Fine Arts	7	4	3	12%	10%	15%
	Business	2	2	0	3%	5%	0%
	PE/Health	3	2	1	5%	5%	5%
	FACS	0	0	0	0%	0%	0%
	Other	7	7	0	12%	18%	0%

Table 4 Continued

		Overall Sample	Wagner Sample	Mozart Sample	Overall %	Wagner %	Mozart %
Grade Level Taught	6^{th}	7	7	0	12%	18%	0%
	$6^{th}/7^{th}$	2	1	1	3%	3%	5%
	$6^{th}/7^{th}/8^{th}$	11	11	0	18%	28%	0%
	7^{th}	18	7	11	30%	18%	55%
	$7^{th}/8^{th}$	9	5	4	15%	13%	20%
	8^{th}	13	9	4	22%	23%	20%
Ethnicity	Black	4	2	2	7%	5%	10%
	Hispanic	2	1	1	3%	3%	5%
	Multiracial	2	2	0	3%	5%	0%
	White	52	35	17	87%	88%	85%
Participation Rate		60/134	40/98	20/36	45%	41%	56%

Table 5 presents the results of a short response question on TUPS concerning the number of years teaching with technology. A high percentage of respondents from both Wagner and Mozart are in their first three years of using technology in the classroom 28% and 25% respectively.

Table 5:

Years Teachers Taught with the Use of Technology

	Years	Number of Teachers	Wagner	Mozart	Overall	Wagner	Mozart
Years Teaching with Tech	1	4	2	2	7%	5%	10%
	2	5	2	3	8%	5%	15%
	3	7	7	0	12%	18%	0%
	4	5	5	0	8%	13%	0%
	5	3	3	0	5%	8%	0%
	6	5	4	1	8%	10%	5%
	7	3	2	1	5%	5%	5%
	8	4	2	2	7%	5%	10%
	9	2	2	0	3%	5%	0%
	10	8	4	4	13%	10%	20%
	11	0	0	0	0%	0%	0%
	12	2	1	1	3%	3%	5%
	13	0	0	0	0%	0%	0%
	14	0	0	0	0%	0%	0%
	15	3	3	0	5%	8%	0%
	16	1	1	0	2%	3%	0%
	17	0	0	0	0%	0%	0%
	18	4	1	3	7%	3%	15%
	19	0	0	0	0%	0%	0%
	20	2	0	2	3%	0%	10%
	25	1	0	1	2%	0%	5%
	28	1	1	0	2%	3%	0%

The qualitative portion of this study used focus group analytics to answer research questions. Three focus groups were conducted. Participants were comprised of classroom teachers at both Wagner and Mozart middle schools. There were two focus groups from Wagner and one group from Mozart. All participants were employed by the district during the study, taught middle school students, and volunteered to participate. Due to the small sample size of the focus groups, in-depth demographic data were not collected.

For the focus groups, the criteria previously established in the methodology were met by all participants. All teachers voluntarily participated. A trained focus group facilitator (see Chapter Three) supervised focus groups, but not the researcher. The teacher focus groups included three teachers in group 1, three in group 2, and six in group 3. The teaching experience within the three focus groups ranged from 2-28 years with an overall average of 15 years. Group 1 teaching experience average was 21 years, group 2 averaged 13 years, and group 3 averaged 16 years.

Figure 7 displays overall reactions from the focus group questions in terms of being coded as positive or negative tone Overall 47% of responses were negative and 53% positive. Analysis by focus group allows for a closer look at school attitudes towards technology integration. Focus group 2 from Mozart Middle School had a 42% positive coding coverage compared to Wagner Middle School which generated the opposite tone with 40% negative code coverage.

Focus Group	**Number of Responses**	**Coverage**	**Number of Responses**	**Coverage**
1 Wagner	14 Positive	24%	20 Negative	35%
2 Mozart	41 Positive	42%	11 Negative	14%
3 Wagner	23 Positive	14%	58 Negative	40%

Figure 7: Positive and Negative Responses from Focus Groups

In Figure 8 code matrix of responses by code is displayed. Group 2 which responded the most positively to questions recognized technology as an *advantage* and provides an *efficiency* to both students and teachers alike. To the contrary, Group 3 was more negative in their responses. Group 3 responders felt *teacher learning* both positively and negatively impacted technology integration. The second most coded response for Group 3 dealt with *student learning*. Overall *Digital Leadership* was viewed negatively along with *Teacher Learning*. *Teacher learning* had the most negative responses. In the positive, overall teachers felt technology was an *advantage* and positively affected *student learning*.

Code	Group 1	Group 2	Group 3	Negative	Positive
Advantage	4	25	3	1	31
After Device Rollout	1	0	0	1	0
Assessment	2	2	3	2	5
Content Focused PD	0	0	3	0	2
Digital Leadership	5	11	14	23	8
Distracted	2	1	10	12	2
Do Differently	6	0	0	4	2
Efficiency	4	21	11	5	32
Feedback	4	5	26	22	14
Homework	5	7	1	4	9
Instructional Coaches	1	3	3	2	6
Internet Access	2	0	0	2	0
Overwhelmed	1	0	2	3	0
Parent Concern	0	0	3	3	0
PD Impractical	0	0	4	3	1
PD Preferences	0	0	7	7	0
PLC	3	8	4	8	7
PLC Social Media	3	2	0	3	2
Repetitive PD	4	1	7	9	3
Student Collaboration	0	4	7	5	6
Student Digital Divide	0	2	11	11	2

Student Learning	11	13	30	29	27
Student Monitoring	1	3	12	10	6
Support	1	10	21	18	14
Teacher Collaboration	4	15	28	25	22
Teacher Evaluation	1	2	7	5	5
Teacher Learning	14	28	58	61	41
Walkthroughs	2	4	0	3	3

Figure 8: Code Matrix

A closer analysis of coding by school provides more detail on the differences between the two schools. For instance, both Mozart and Wagner responses were coded as negative in relationship to *Digital Leadership, Feedback, Student Learning, Teacher Collaboration, and Teacher Learning.* An example of these responses from a focus group participant indicated, “Administrators are not very much involved with what we're doing with technology.” Another participant shared, “Putting limits on how students can share documents stifles student collaboration, which negatively impacts student learning.” Additionally, in regard to teacher learning, one responder said, “Professional development seems more geared to elementary versus secondary. We need more content specific training.” Overall Mozart responses were more positive than Wagner. Mozart had a high frequency of positive responses in *Advantage* and *Efficiency*, while Wagner has no high frequency positive responses. A Mozart focus group participant said, “Our learning management system allows us to organize everything into one place.” Both middle schools had the highest frequency of negative responses in the area of *Teacher Learning*. Discussion about *Teacher Learning* involved comments that training was too repetitive and often times more remedial than needed. One focus group respondent said, “I don’t think there’s a universal focus on how to use the technology in our district.”

Although negative or positive responses are not a specific indication of the attitudes on 1:1, they are an aggregate of the responses to focus group questions on topics such as student learning, professional development model, digital leadership, and strengths of the 1:1 rollout. A complete list of the focus groups questions can be found in Appendix E.

In summary, some focus group analysis reinforced data gathered from the quantitative results. Both qualitatively and quantitatively teachers' *perceptions of technology use* at Mozart were more positive than negative. *Digital leadership*, which had negative responses at both Mozart and Wagner, was not statistically significant from the quantitative analysis. Although *Teacher Learning* had overall negative responses, the quantitative analysis only examined the timing of professional development and not the quality.

Inferential Statistics

The inferential statistics section addresses each of the four research questions. Specifically, for each question, an appropriate statistical tool was utilized to investigate professional development and implementation of 1:1 technology in the middle school classroom for the overall data generated from TUPS Survey, TIM-O Observation Matrix, and focus groups. These statistical analyses were performed for middle school teachers from two districts in Indiana in their second and third year of 1:1 technology implementation.

This section is organized based on the four research questions. Both quantitative and qualitative results will be explained. The quantitative results were based on teacher data from the TUPS survey and the TIM-O classroom observation tool. The qualitative results were based on open-ended questions presented to focus groups in both schools.

Research Question 1: Based on the perceptions of middle school teachers, what practices motivated the deepest level of technology implementation (i.e. formal professional development pre-implementation or concurrent to implementation, digital leadership, teacher initiative, or school culture)?

Research question one investigated teacher perceptions of technology through the lens of what motivated the deepest level of implementation. The questions specifically explored professional development before technology implementation, professional development concurrent to technology implementation, digital leadership (specific administrator leadership), and teacher initiative or the culture of the specific building implementing technology. To answer this question teachers completed survey questions using the TUPS survey. The survey data allowed for the analysis of the research question using inferential statistics of t-tests, one-way ANOVA, as well as correlation analysis.

In order to identify differences between Mozart Middle School and Wagner Middle School and constructs of *Technology Access and Support*, *Perception of Technology Use*, *Confidence and Comfort Using Technology*, *Technology Integration*, and *School Climate,* a t-test was performed. Each of constructs came from the TUPS survey. In Table 6, the t-test compared the means of the two schools to identify significant differences between these. The t-test also indicated where significant differences were when comparing each construct. Participants from both Mozart (n=18) and Wagner (n=41) generally completed all survey items throughout all constructs. Comparing the means of Wagner to those of Mozart, the two schools were relatively consistent. For example, the means for *Technology Access and Support* are higher for both (M 5.18 & W 6.1) than *Technology Integration* (M 3.16 & W 3.37).

Table 6:

Mean of Constructs from TUPS Survey

	School	N	Mean
Technology Access and Support	Mozart	18	5.1759
	Wagner	42	6.102
Perception of Technology Use	Mozart	18	5.6515
	Wagner	42	5.7424
Confidence and Comfort Using Technology	Mozart	18	5.1465
	Wagner	41	5.5215
Technology Integration	Mozart	18	3.166
	Wagner	39	3.3708
School Climate	Mozart	17	5.5294
	Wagner	39	5.5769

To confirm this finding, a one-way ANOVA was run comparing *Technology Integration* in each middle school to professional development done before technology implementation. Prior to the ANOVA analyses, the Levene's test of homogeneity of variances determined that the homogeneity assumption was met and ANOVA could be used. The ANOVA compared responders who answered positively (somewhat agree, agree, and strongly agree) on question 67 of the TUPS survey which asked, "I believe professional development received before student device rollout positively impacted by ability to integrate technology" to the level of technology integration perceived by the teacher. The ANOVA in Table 7 showed no statistical significance (p=.536) between positive responses on question 67 and the level of technology integration. This means that a deeper level of technology integration did not occur with professional development before student device rollout.

Table 7:

ANOVA Professional Development Before Implementation and Technology Integration

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.948	2	.474	.634	.536

Within Groups	32.177	43	.748		
Total	33.126	45			

Since professional development before implementation appears to have no significant impact on technology integration in this study, another ANOVA was completed to analyze the impact of professional development after implementation. The Levene's test of homogeneity of met the homogeneity assumption. The ANOVA compared question 68 which states, "I believe professional development received after student device rollout positively impacted by ability to integrate technology" to the level of technology integration. As in Table 8, a comparison was made by responders that answered "somewhat agree, agree, and strongly agree" to their levels of technology integration. The ANOVA results in Table 6 show no statistical significance (p=.716) between positive responses to question 68 and technology integration. This means professional development after technology integration had no bearing on the level of technology implementation in this particular study.

Table 8:

ANOVA Professional Development After Implementation and Technology Integration

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.504	2	.252	.336	.716
Within Groups	39.029	52	.751		
Total	39.533	54			

To further explore the relationship between professional development before implementation and technology integration, an additional construct was added to the analysis using regression. Regression analysis is a set statistical processes to estimate relationships among variables. Regression focuses on the relationship between a dependent variable and one or more independent variables. In Table 9, the regression analysis used the dependent variable of the *Technology Integration* construct from the TUPS survey. The dependent variables of the analysis used the construct of *Perception of Technology Use* and a positive response (somewhat agree, agree, and strongly agree) to question 67, “I believe professional development received before student device rollout positively impacted by ability to integrate technology.” The regression analysis indicated a statistically significant (*p*=.000) relationship between the dependent variable and two independent variables. This means that by combining question 67 about the impact of professional development before implementation and the construct of *Perception of Technology Use* had a strong influence on the level of technology implementation. Teachers who felt positively about professional development before device rollout, coupled with a positive perception of technology, had a deeper level of 1:1 implementation.

Table 9:

Regression Analysis Using Professional Development Before Technology Integration and Perception to Technology Integration

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10.202	2	5.101	9.216	.000b
	Residual	29.337	53	0.554		
	Total	39.539	55			

a. Dependent Variable: Technology Integration
b. Predictors: Professional development before technology integration, Perception of Technology Use

Correlation analysis is a method of statistical evaluation used to study the strength of a relationship between two continuous variables. Variables in this correlation analysis were constructs from TUPS survey that included *Perceptions of Technology Use, Confidence Using Technology*, *Technology Access*, *Technology Integration*, *School Climate, Professional Development Before Technology Integration*, *Professional Development After Technology*

Integration, and *Feedback on Technology Integration*. Correlation analysis is useful when researchers want to establish possible connections between variables.

Correlation is a technique for investigating the relationship between two variables. Pearson's correlation coefficient (r) is a measure of the strength of the association between the two variables. The tables 10-17 utilized Pearson’s correlation coefficient to measure correlation. Correlations are considered significant when $p<0.05$ and very significant when $p< 0.01$. In table 10, *Perceptions of Technology Use* have a strong correlation between *Confidence Using Technology* (r=.561, p=.000), *Technology Integration* (r=.343, p=.009), and *School Climate* (p=.006). *Professional Development After Implementation* (r=.365, p=.048) although not as strong as *Confidence Using Technology* and *Technology Integration*. *School Climate* (r=.266, p=.048) has a correlation to *Perceptions of Technology Use*. In other words, if teachers have a positive perception of technology, their confidence using and integrating technology in the classroom was higher. Additionally, perceptions of technology were strongly aligned to *School Culture,* meaning perceptions of use were increased with a positive culture in the building. Surprisingly, there is a strong correlation between perceptions of use and professional development after technology implementation. This will be discussed more in Chapter 5.

Table 10:

Correlation Between Perceptions of Technology Use and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	60	.392	.112
Confidence Using Technology	59	0	.561**
Technology Integration	57	.009	.343**
School Climate	56	.006	.365**
PD Before Technology Integration	57	.264	.152
PD After Technology Integration	56	.048	.266*
Feedback on Technology Integration	56	.244	.158

*Note: **p< 0.01 level * p> 0.05 level*

Technology Access and Support constructs in the TUPS survey investigated the availability of technology specialists to assist teachers in the implementation of technology in the classroom. The constructs used a Likert scale of *Strongly Agree-Strongly Disagree* and range from statements about adequate time for a technology specialist to assist teachers to the types of instructional practices teachers prefer when the technology specialist was working with them. When comparing the construct of *Technology Access and Support* to the other TUPS constructs there were strong correlations between *School Climate* (r=.350, p=.008) and a definitive correlation between *Technology Integration* (r=.016, p=138).

The strong correlation between *Technology Access and Support* and *School Climate* was not surprising. Respondents who had positive experiences with technology specialists and are willing to ask for and acquire assistance must feel comfortable with the school climate. Additionally, and less surprisingly, was the correlation between working with a technology specialist and the level of technology implementation. In other words, access and support from technology specialists can provided a deeper level of technology implementation.

Table 11:

Correlation Between Technology Access and Support and Other Constructs

Construct	N	Sig.	Pearson Correlation
Perception of Technology Use	60	.392	.112
Confidence Using Technology	59	.086	.226
Technology Integration	57	.016	.318*
School Climate	56	.008	.350**
PD Before Technology Integration	57	.078	.238
PD After Technology Integration	56	.114	.213
Feedback on Technology Integration	56	.386	.118

*Note: **p< 0.01 level * p< 0.05 level*

In Table 12, the correlation between *Confidence Using Technology* and the constructs from the TUPS survey showed some additional strong correlations. Those strong correlations included *Technology Access and Support*, *Technology Integration*, and *Professional Development after Device Rollout*. The two strongest correlations with a $p<0.01$, were *Technology Access and Support* (r=.561, p=.000) and *Technology Integration* (r=.486, p=.000). The third strong correlation was *Professional Development After Device Rollout* p=.006. The analysis concluded that confidence with using technology as teacher from the beginning provided a willingness for the teacher to seek support from a technology specialist and have deeper levels of technology integration. *Professional Development After Device Rollout*, would also make sense. A teacher who had confidence using technology in the classroom will not need training in the basic use of technology. The more advanced training that occurs after device rollout would be more beneficial for the teacher.

Table 12:

Correlation Between Confidence Using Technology and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	59	0	.561**
Perception of Technology Use	59	.085	.226
Technology Integration	57	0	.485**
School Climate	56	.208	.171
PD Before Technology Integration	57	.074	.421
PD After Technology Integration	56	.006	.363**
Feedback on Technology Integration	56	.495	.093

*Note: **p< 0.01 level * p> 0.05 level*

Technology integration construct had correlations to three of the other constructs in the TUPS survey. In Table 13, the strong correlations included *Technology Access and Support* and *Professional Development Before Device Rollout*. *Technology Access and Support* (r=.243, p=.009), *Professional Development Before Device Rollout* (r=.418, p=.001) and the third correlation of *Perception of Technology Use* (*r*=.318, *p*=.016), not surprisingly, were closely associated with *Technology Integration*. This means the three constructs of *access and support*, *professional development before rollout*, and *perception of technology use* were dependent on the level of technology integration. The positive attitude of teachers, regardless of when professional development occurred, allowed for a deeper level of technology integration.

Table 13:

Correlation Between Technology Integration and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	57	.009	.243**
Perception of Technology Use	57	.016	.318*
Confidence Using Technology	57	0	.485
School Climate	56	.155	.255
PD Before Technology Integration	56	.001	.418**
PD After Technology Integration	56	.126	.207
Feedback on Technology Integration	56	.130	.205

*Note: **p< 0.01 level * p> 0.05 level*

Table 14 presents the correlations between School Climate and other TUPS Survey constructs. Strong correlations exist between *Technology Access and Support* (*r*=.365, *p*=.006), *Perceptions of Technology Use* (*r*=.350, *p*=008), and *Feedback on Technology Integration* (*r*=.405, *p*=.002) and *School Climate*. This means that school climate can have an effect on how teachers view work with technology specialists, how they as individuals perceive technology, how it is used in the classroom, and how they individually take feedback on technology integration. In summary, responders who work in a positive school climate will accept feedback on technology integration, celebrate successes, and work to improve deficient practices.

Table 14:

Correlation Between School Climate and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	57	.006	.365**
Perception of Technology Use	56	.008	.350**
Confidence Using Technology	56	.208	.171
Technology Integration	56	.255	.155
PD Before Technology Integration	56	.811	.033
PD After Technology Integration	56	.468	.095
Feedback on Technology Integration	56	.002	.405**

*Note: **p< 0.01 level * p> 0.05 level*

Professional development has been a vital part of a technology initiative. Table 15 and 16 investigated professional development before or after device rollout to determine correlations between other constructs from the TUPS Survey. In Table 13, strong correlations existed between *School Climate* (r=.416, p=.001), *Professional Development After Technology Rollout* (r=.468, p=.000), and *Feedback on Technology Integration* (r=.352, p=.008). School climate, in most cases, will have a relationship to the success levels of professional development. The correlation between professional development before and after device rollout would demonstrate the importance of ongoing training after the initial rollout of devices. Finally, feedback on technology integration would correlate with professional development before device rollout as an opportunity to inform the teacher on the level of implementation.

Table 15:

Correlation Between PD Before Technology Integration and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	56	.264	.152
Perception of Technology Use	56	.078	.238
Confidence Using Technology	56	.074	.241
School Climate	56	.001	.416**
Technology Integration	56	.033	.811
PD After Technology Integration	56	.000	.468**
Feedback on Technology Integration	56	.008	.352**

*Note: **p< 0.01 level * p> 0.05 level*

Professional Development After Device Rollout correlated to other TUPS constructs in Table 16. There are four constructs with correlation to *Professional Development After Device Rollout*, two of which were considered strong. *Technology Access and Support* (*r*=.213, *p*=.114) and *Feedback on Technology Integration* (*r*=.271, *p*=.271) correlate with *Professional Development After Device Rollout*. Two constructs had strong correlations *Confidence Using Technology* (*r*=.363, *p*=.006) and *Professional Development Before Device Rollout* (*r*=.468, *p*=.001). Professional development before and after device rollout had a strong correlation to each other. Ongoing professional development is critical to ensure educational initiatives thrive and achieve goals. It is not surprising these two constructs have the strongest correlation (*p*=.001). The other construct with strong correlation is *Confidence Using Technology*. *Confidence Using Technology* has had a strong correlation with many on the constructs. This correlation is not surprising since fear or using technology is often considered a barrier to implementation.

Table 16:

Correlation Between PD After Technology Integration and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	56	.114	.213*
Perception of Technology Use	56	.048	.266
Confidence Using Technology	56	.006	.363**
School Climate	56	.486	.095
Technology Integration	56	.126	.207
PD Before Technology Integration	56	.001	.468**
Feedback on Technology Integration	56	.043	.271*

*Note: **p< 0.01 level * p> 0.05 level*

Feedback on Technology Integration in Table 17 show correlations between three constructs with two considered strong. Professional Development After Device Rollout (r=.278, p=.043) has a correlation to feedback. Both *School Climate* (*r*=.404, *p*=.002) and *Professional Development Before Device Rollout* (*r*=.352, *p*=.008) had strong correlations to *Feedback on Technology Integration*. Professional development both before and after device rollout had correlations to feedback on technology integration. Surprisingly, *Professional Development Before Device Rollout* (p=.008) had a strong correlation where after rollout did not. This means that feedback on integration before device rollout may be more important to respondents than feedback after rollout. Not surprising, was a strong correlation between *School Climate* (*p*=.002) and feedback. *School Climate* had a direct relationship to the success of any initiative.

Table 17:

Correlation Between Feedback on Technology Integration and Other Constructs

Construct	N	Sig.	Pearson Correlation
Technology Access	56	.386	.118
Perception of Technology Use	56	.244	.158
Confidence Using Technology	56	.093	.093
School Climate	56	.002	.404**
Technology Integration	56	.130	.205
PD Before Technology Integration	56	.008	.352**
PD After Technology Integration	56	.043	.271*

*Note: **p< 0.01 level * p> 0.05 level*

In summary, confidence and comfort level using technology led to a deeper implementation level according to data analysis. Additionally, professional development before technology integration appears to influence the level technology implementation. One other indicator also affected the level of integration that includes *Teacher Perceptions of Technology Use*. Formal professional development concurrent to implementation appears to be successful when correlated with school climate and confidence using technology. The same is true when looking at teacher initiative. Teacher initiative is contingent upon school climate, access to supports like technology coaching, comfort level using technology, and the perception of technology use. Digital leadership had no direct correlation to the level of technology implementation, but certainly contributed to school culture. Additionally, no one single variable has more influence than another on the level of technology implementation.

Research Question 2: How do stakeholders perceive changes in instructional practices have occurred since the technology implementation based on the ISTE-Coaching and Teaching Standards?

Research question two explored the types of instructional practices that have changed as part of technology integration. To satisfy the question, both quantitative and qualitative data were used. The quantitative data was gathered from the TUPS survey tool, while qualitative data was drawn from teacher focus groups.

For quantitative analysis, the Levene's test of homogeneity of variances was performed to determine that the assumptions were met. After analysis the Levene's test the homogeneity assumption were met allowing for a two-sample t-test. The two-sample t-test uses the Technology Integration constructs from the TUPS survey to analysis the different instructional practices. Table 18 lists 16 instructional practices used as part of technology integration. Respondents were asked how frequently each instructional practice was used in classrooms. The frequency range was *Several Times Per Day* to *Less Than One Time Per Month.* Table 18 represents the aggregate of both Mozart and Wagner School respondents. The analysis indicated only one statistically significant change in instructional practice. That change was *As a Student Presentation Tool*(p=.014). This means students are using technology in the classroom more frequently as a presentation tool. All other instructional practices were not statistically significant.

Table 18:

Technology Integration Instructional Practices T-Test

Instructional Practice	*T*	*Df*	*P*
Small Group Instruction	-1.035	55	.305
Individual Instruction	-.663	55	.510
Cooperative Groups	-.808	55	.422
Independent Learning	.554	55	.587
As an Extension Activity	.000	55	1.00
As a Reward	-1.161	54	.251
To Tutor for Remediation	-1.388	53	.171
As a Research Tool for My Students	-1.250	54	.217
As a Tool for Students to Use in Planning and Managing Projects	-.897	54	.374
As a Productivity Tool for My Instruction	-.265	54	.792
As a Student Presentation Tool	-2.531	54	.014
Student Discussion/Communication	-1.138	54	.260
Instructional Delivery	.370	54	.713
As a Communication Tool	.675	54	.503
To Create Online Content for My Students	-.280	54	.781
To Assess Student Learning	-.464	54	.645

When comparing Mozart and Wagner independently using the same instructional practices were their significant differences? Table 19 analyzed the means between the two schools to identify statistically significant differences. Between the two schools, Mozart and Wagner, there were no statistically significant variances.

Table 19:

TUPS Level of Technology Integration Questions Group Statistics

	I am an instructor at:	N	Mean
Small Group Instruction	Mozart	18	2.94
	Wagner	39	3.33
Individual Instruction	Mozart	18	3.56
	Wagner	39	3.82
Cooperative Groups	Mozart	18	2.89
	Wagner	39	3.18
Independent Learning	Mozart	18	4.11
	Wagner	39	3.95
As an Extension Activity	Mozart	18	3.00
	Wagner	39	3.00
As a Reward	Mozart	17	2.24
	Wagner	39	2.64
To Tutor for Remediation	Mozart	17	2.88
	Wagner	38	3.45
As a Research Tool for My Students	Mozart	17	3.12
	Wagner	39	3.59
As a Tool for Students to Use in Planning and Managing Projects	Mozart	17	2.41
	Wagner	39	2.74
As a Productivity Tool for My Instruction	Mozart	17	3.47
	Wagner	39	3.59
As a Student Presentation Tool	Mozart	17	1.88
	Wagner	39	2.72
Student Discussion/Communication	Mozart	17	2.12
	Wagner	39	2.54
Instructional Delivery	Mozart	17	4.35
	Wagner	39	4.21
As a Communication Tool	Mozart	17	4.53
	Wagner	39	4.23
To Create Online Content for My Students	Mozart	17	3.00
	Wagner	39	3.13
To Assess Student Learning	Mozart	17	3.71
	Wagner	39	3.87

Qualitative data from teacher focus group questions provided some specific insights about the changes in instructional practices. All three focus groups were asked, "*How has the increased integration of technology affected student learning? How has your instruction changed since the implementation of the 1:1? Specifically, how have your administrators supported student learning?"* Responses overall (54%) were positive to the question, with teachers listing changes to instruction that included improved student assessment, engagement, student collaboration, efficiency in finding information, and independent learning. These instructional practices aligned with ISTE Teacher Standard 1, *Facilitate and inspire student learning and creativity* and ISTE Coaching Standard 2 *Teaching, Learning, and Assessments*. A greater change to instruction is student access to technology in their home.

At both Wagner and Mozart middle schools, students are able to take devices home, aligning to ISTE Teaching Standard 3 *Digital age learning environment*s. By taking devices home students had access to teacher-made materials, apps, and websites that created asynchronous learning opportunities beyond traditional homework. Additionally, students used technology through video tutorials for reteaching opportunities. One teacher who taught instrumental music stated, “Most of our kids don’t have somebody in the home who already knows how to play an instrument. So, they don’t have that help, but when they use their Chromebooks, they have almost like a helper with them at all times.” Students could also access software that performed music for students to ensure that they were playing the correct notes and rhythms. Beyond music, technology created reteaching and tutorial options in other core content (English, math, science, and social studies) classrooms, especially when students did not have supports in the home.

Real world and authentic learning opportunities were also enhanced with use of 1:1 technology. In the science classroom, students used software to create an interactive periodic table, which changed instruction from basic memorization to more application and creation. In the world language classroom, the use of video in the classroom provided a deeper understanding of cultures and language dialects. A world language teacher said, “In my world language classroom, technology gives exposure to more cultures and different types of dialects. That would not have happened if they were just sticking with the textbook."

With the positives of 1:1 technology, there were also negatives. At Wagner Middle School, many students did not have Internet access in their home, making it difficult to complete assignments or take advantages of resources available through the Internet. Although some of the online content could be accessed in off line mode, it requires students to plan in advance (which can be difficult). One teacher noted, "If they don't have Internet, they have to remember to upload assignments before they go home. We have some kids who forget to do that, and then they're home and they're without what they need." A lack of internet access at home was not mentioned at Mozart Middle School. This could be due to a more urban setting and lower rate of students living at or below poverty threshold.

A negative aspect noted by teachers in all groups was student monitoring while using technology and distractions. Both of these issues come from area of digital citizenship, which is ISTE Teacher Standard 4, *Promote and model digital citizenship and responsibility*. Teachers shared concerns that monitoring where students navigate online was difficult. Students will often navigate to gaming sites or YouTube channels during instructional time. Teachers found it difficult to monitor, since students efficiently move from classroom content to other sites without detection. A teacher shared, "Students are easily distracted a lot of times with games and other websites."

In summary, quantitative analysis using TUPS survey demonstrated using technology as a presentation tool was statistically significant when compared to 20 other instructional practices surveyed. When comparing the two middle schools Wagner and Mozart with the same instructional practices, there were no statistically significant differences, demonstrating similar practices in both schools. Qualitative analysis from teacher focus groups indicate an overall positive opinion of changes after technology implementation. Positive changes include: higher student capacity for independent learning, improved student engagement during instruction, and technology used at home as an opportunity for reteaching, video tutorials, and learner supports. Negative aspects of the implementations included lack of home Internet connections, student monitoring while using technology, and student distraction from games and other websites.

Research Question 3: When comparing two schools, one using pre-implementation practices and the other concurrent practices, which school has the deepest level of implementation measured by ISTE-Coaching and Teaching Standards?

Research question 3 compared the two schools and the level of implementation in each school. Wagner Middle School used pre-implementation practices, meaning professional development occurred before technology implementation, and teachers received devices before students. Mozart Middle School used concurrent practices, meaning professional development occurred while devices were deployed, and teachers had little to no experience with devices before students. To measure the level of implementation, the TIM-O observation matrix was used. Each classroom was randomly selected for a 10-minute observation. After the ten-minute observation, the observer answered a series of questions to determine the level of technology integration.

In Table 20, group statistics were used to analyze observational data of the two middle school buildings involved in the study. Ten classrooms were randomly selected at both Wagner and Mozart middle schools. The group statistics compared both Wagner and Mozart to classroom environment of *Active*, *Collaborative*, *Constructive*, *Authentic*, and *Goal Directed*. The statistical analysis indicated no statistically significant differences in classroom environment between the two buildings.

Table 20:

Observational Data Using TIM-O Matrix Group Statistics

	School ID	N	Mean
Active	Wagner	10	2.00
	Mozart	10	2.50
Collaborative	Wagner	10	1.50
	Mozart	10	1.80
Constructive	Wagner	10	1.90
	Mozart	10	2.40
Authentic	Wagner	10	1.60
	Mozart	10	1.80
Goal-Directed	Wagner	10	1.40
	Mozart	10	1.60

In addition to classroom environment, the TIM-O matrix also used five levels of technology integration that include *Entry*, *Adoption*, *Adaption*, *Infusion*, and *Transformation*, the lowest level being *Entry* and the highest *Transformation*. The Levene's test of homogeneity of variances was performed to determine that the assumptions were met. After checking for homogeneity assumption with the Levene's test, a t-test analysis was run.

Table 21 presents data from an independent t-test based on observational data from the TIM-O. The observational data included the five levels of technology integration: *Entry*, *Adoption*, *Adaption*, *Infusion*, and *Transformation.* The TIM-O matrix identified the frequency of technology integration and assigns a level from the five descriptors of *Entry*, *Adoption*, *Adaption*, *Infusion*, and *Transformation.* Analysis indicated that Wagner (m=2.02) and Mozart (*m*=1.68) Middle Schools had no statistically significant differences in their level of technology integration.

Table 21:

TIM-O Technology Integration Levels T-Test

	School ID	N	Mean	SD
Mean Integration Score Across Levels	Mozart	10	1.68	.83905
	Wagner	10	2.02	.51164

To further analyze observational data from TIM-O, a Mann-Whitney U-Test was conducted. The two independent variables for the test were observations from Wagner and Mozart Middle School. The dependent variable is the data from the TIM-O observations. A Mann-Whitney Test was used when data is ordinal or when assumptions are not met. In this case, data was ordinal. Since the sample size was small, a Wilcoxon W test was applied. Table 22 examines the mean integration score across levels resulting in the finding that the test was not significant ($p=.108 > .05$). This indicates that there was no significant difference in the level of technology integration at Wagner and Mozart Middle schools.

Table 22:

TIM-O Technology Integration Levels Mann-Whitney Test

	Mann-Whitney U	Wilcoxon W	Sig	Exact Sig
Mean Integration Score Across Levels	29.00	84.00	.108	.123

In summary, Wagner Middle School used pre-implementation strategies, and Mozart Middle School used concurrent strategies to implementation 1:1 technology. Did one of these strategies yield a deeper level of technology integration? Using the TIM-O matrix, classroom observations were performed. The classroom observations provided levels technology integration as well as classroom environment. Quantitative analysis of the findings showed no statistically significant difference between the two implementation strategies.

Research Question 4: What are the differences in ISTEP+ and NWEA assessment data, comparing pre- and post-implementation data of 1:1 technology in both districts?

Both Mozart and Wagner Middle Schools have fully implemented 1:1 technology initiatives. With fully implemented 1:1 initiatives, what is the effect on statewide and district level assessment data? To analyze trends in assessment data, this study used longitudinal data from both ISTEP+ and NWEA. For Mozart Middle School the study examined two years of data since the building configuration is grades 7/8, and three years of data for Wagner Middle School since it contains grades 6/7/8.

Table 23 compares ISTEP+ pass rates in math and English language arts from 2015-2017 for both Mozart and Wagner middle schools. From 2015-2017, Mozart Middle School pass rates declined 33% in math and 17% in English language arts. Wagner Middle School ISTEP+ pass rates for math from 2015-2017 were unchanged at 32%, while English language arts declined 4% over the same period. It was unclear if the negative or neutral impact on ISTEP+ pass rates could be directly associated with implementation of 1:1 technology this will be discussed further in Chapter Five.

Table 23:

Longitudinal ISTEP Data for Mozart and Wagner Middle Schools

School	School Year	Math	ELA
Mozart	2017	40%	49%
	2016	61%	62%
	2015	73%	66%
Wagner	2017	32%	41%
	2016	31%	43%
	2015	32%	45%

Note. Percentages reflect the number students achieved passing

Another source for achievement data was NWEA math, reading, and language arts. Both schools used NWEA as district level assessment data. Table 24 is organized by cohort groups representing when students entered the middle school and then left. The score listed in the table is the average RIT score for one grade level. Organization by cohort should measure the relationship of 1:1 technology on students through their middle school years. Since Mozart is a 7/8 building, Table 24 measured student growth from the fall of 2016 to the fall of 2017. Mozart students attained average RIT growth in math, reading, and language arts with an average growth of 5 points. Wagner Middle School examines growth for three years starting with fall of 2015. In both 2016 and 2017, the average RIT score improved more than 2 points consecutively. Wagner's RIT growth, like Mozart, exceeded average growth. 1:1 technology may have had a positive effect on NWEA assessment data however, it is difficult to determine. More discussion on this topic occurs in Chapter Five.

Table 24:

NWEA Cohort Growth Between Schools with fully implemented 1:1

School	Subject Area	Fall 2015	Fall 2016	Fall 2017
Mozart	Math		224.3	229.9*
	Reading		214.2	219.2*
	LA		212.9	219.1*
Wagner	Math	214.9	219.8*	229.6*
	Reading	206.8	212*	216*
	LA	209.9	213.7*	215.4*

Implementation of 1:1 technology had a negative or neutral relationship to student pass rates on ISTEP+. On average student cohorts attained average RIT score growth in math, reading, and language arts on NWEA assessments.

Summary

The results reported in this chapter provide data to answer the four research questions. The purpose of this study was to identify the relationship between effective professional development and the level of implementation of 1:1 technology integration in the middle school classroom. The results indicated that teachers' confidence and comfort level using technology led to a deeper technology implementation level. Professional development before technology integration appears to influence the level of technology implementation, as well as perceptions of technology use. Formal professional development concurrent to implementation appears to be successful when correlated with school climate and confidence using technology. *Teacher initiative*, access to supports like technology coaching, *comfort level using technology*, and *the perception of technology use* demonstrate strong technology implementation and have a direct relationship to *school climate*. However, this study found digital leadership has no direct correlation to the level of technology implementation.

Comparing both schools, there were no statistically significant differences in the level of 1:1 implementation. Qualitative analysis from teacher focus groups indicate an overall positive opinion of changes after technology implementation. Additionally, quantitative analysis of the findings showed no statistically significant differences between the pre-implementation and concurrent strategies providing a deeper level of implementation.

Implementation of 1:1 technology has had a negative or neutral effect to ISTEP+ pass rates at both schools. NWEA longitudinal data shows cohort groups attaining average RIT score growth during time immersed in 1:1 implementation. The data reported in this chapter will be discussed in detail in Chapter 5.

CHAPTER FIVE

CONCLUSIONS

Chapter Five begins with a brief summary of the study, which specifically addresses the research questions. Then the findings are compared to the research literature in Chapter Two regarding professional development, implementation strategies, and levels of technology integration. Finally, the chapter will conclude with implications for practice and suggestions for further research.

Purpose of the Study

The purpose of this study was to identify the relationship between effective professional development and the level of implementation of 1:1 technology integration in the middle school classroom. The effectiveness of professional development and instructional practices were measured by teacher observations, a survey, and focus groups using the International Society for Technology in Education (ISTE) Teacher Standards. The independent variables included: initial comfort level with technology, gender, age, years of experience, content area, and educational setting (general education/special education/honors). Further, the dependent variables included the measurement of both technology integration measured by Learning Forward and ISTE-Coaching and Teacher Standards using observational rubrics.

Research Questions

The research questions that guided this study were:

R_1 Based on the perceptions of middle school teachers, what practices motivated the deepest level of technology implementation (i.e. formal professional development pre-implementation or concurrent to implementation, digital leadership, teacher initiative, or school culture)?

R_2 How do stakeholders perceive changes in instructional practices have occurred since the technology implementation based on the ISTE-Coaching Standards?

R_3 When comparing two schools, one using pre-implementation practices and the other concurrent practices, which school has the deepest level of implementation measured by ISTE-Coaching Standards?

R_4 What are the differences in ISTEP+ and NWEA assessment data, comparing pre- and post-implementation data of 1:1 technology in both districts?

Overview of the Problem

Public schools in the United States now provide at least one computer for every five students. In 2015-16, more standardized tests for the elementary and middle grades were administered via technology than by paper and pencil (Herold, 2016). The immersion of technology in our classrooms is evident. However, a significant body of research clearly expresses that districts have been slow to transform instructional practice, despite the influx of new technology into classrooms (November, 2013). Only a very limited amount of evidence has indicated that technology and online learning improves student achievement (Means et al., 2009). So why does technology seemingly not provide the return on investment? The education community would cite a lack of professional development in the practices of technology implementation.

The relationship of technology immersion and student achievement may have little to do with the amount of professional development, but rather be related to the effectiveness of the training. Put simply, effective professional development for teachers is job-embedded and extended over a period, which makes it both relevant and authentic.

The problem schools face with effective technology integration is the speed of implementation keeping pace with teacher professional development. What was largely unknown from previous research was the point where schools can solidify a return on investment in relation to student achievement. The implementation and professional development model that yields the highest acquisition of technology integration was also unclear. Finally, I was interested in investigating how instructional practices have changed in classrooms with high levels of technology integration.

Review of the Research Methods

This study used quantitative with qualitative aspects approach as its research design, but not considered fully mixed methods. According to Tashokkori (2009), parallel mixed methods design permits researchers to triangulate results from the separate qualitative and quantitative components of research to confirm or cross-validate findings from a single study (Creswell, Plano-Clark, Gutmann, & Hanson 2003). With a mix of close-ended survey questions and open-ended interviews/observations, a mix of quantitative and qualitative research provided more divergent views than traditional qualitative and quantitative research alone (Tashokkori &

Teddlie, 2009). With data from a mixed method approach, this study analyzed specific 1:1 technology implementation and defined what practices lead to the deepest technology integration. This study used closed ended quantitative components through survey and classroom observation. Additionally, the study used open-ended qualitative components in the form of teacher focus groups. Focus group questions were developed after analyzing both TIM-O and TUPS results. Focus group questions were designed to provide deeper insights into the quantitative data.

Major Findings

The following is a brief description of the findings supported in this research.

- Professional development held before or concurrently to implementation has no relationship to the level of technology implementation.
- Professional development held before or concurrent to implementation coupled with a positive *perception of technology use* lead to a deeper level of technology implementation.
- *Access and support from a technology specialist* provided a deeper level of technology integration.
    - Teachers willingness to accept help from a technology specialist has a direct correlation to *teacher's comfort level with technology use*.

- School climate has a direct relationship to teacher views on *work with a technology specialist*, *perception of technology use*, and *the level of technology integration*.
- *School climate* has a strong correlation to the success levels of professional development.
- *Digital leadership* has no direct correlation to the level of technology implementation.
- Teachers have a positive perception of technology integration and observe:
    - Improved student engagement
    - A closure of the opportunity gap (access to technology at home)
    - Higher student capacity to work independently
- Negative impacts on technology implementation include:
    - Student monitoring while on devices
    - No Internet connections in the home
    - Student distractions
- Technology integration had little to no impact on student assessment data.

Findings Related to the Literature

In this section I will discuss my finding as it relates to the literature. Some of the literature strengthens my findings and provides evidence of strategies that yield higher levels of implementation. My findings will be organized by research question. I used both quantitative and qualitative analysis to reach my findings. When a finding impacts more than one research question, the finding will be discussed in the first research questions and be referenced thereafter.

Research Question 1: Based on the perceptions of middle school teachers, what practices motivated the deepest level of technology implementation (i.e. formal professional development pre-implementation or concurrent to implementation, digital leadership, teacher initiative, or school culture)?

Results from Chapter Two, much like this study, yielded mixed results when it comes to practices that motivated the deepest level of technology implementation. This study found no relationship between professional development pre-implementation or concurrent to implementation and which provided the deepest level of technology implementation. A long-standing notion in education is that implementing a new educational technology will transform the classroom and student learning (Groff & Mouza, 2008). Even though students have access and readily use 21st Century technologies outside of school, educators and schools have been slow to embrace technology for instructional purposes to enhance student learning (Downes & Bishop, 2012). To this end, the careful and deliberate planning of professional development is critical.

Durant, Brunvand, Ellsworth, & Şendağ (2012) stated: "research-based professional development that is sustained, student-centered, participatory, and supported by adequate resources can have a significant impact on teacher learning about specific technologies and the level of integration of these technologies in the classroom, demonstrating the effectiveness of research-based practice and scope of implementation on teacher and student learning (p. 4321)."

TUPS results determined that professional development in both schools was sustained, student centered, participatory, and adequately supported.

Research has consistently indicated that high-quality professional development activities are longer in duration (contact hours plus follow-up), provide access to new technologies for teaching and learning, actively engage teachers in meaningful and relevant activities for their individual contexts, promote peer collaboration and community building, and have a clearly articulated and a common vision for student achievement (Lawless & Pellegrino, 2007).

The second finding in this study indicated professional development held before or concurrent to implementation coupled with a positive perception of technology use lead to a deeper level of technology implementation. This a bit of a contradiction to the finding above, but not surprising. Throughout Chapter Four, teacher attitudes and access to technology typically led to classrooms with deeper levels of implementation. By correlating professional development pre-implementation and concurrent to implementation to positive perceptions of technology use by teachers demonstrates that fact the teacher predispositions are critical to a technology implementation. This implication of this finding also might suggest that school district leaders should question if they are wasting money by deploying devices to teachers who possess a negative mindset about technology integration and use.

Teachers consider problems with equipment, scheduling difficulties (with lab-based technology), software availability, and lack of training as barriers to technology implementation (Wright, 2011). With these barriers in mind, teachers may believe that technology integration is not worthwhile and can be exhausting to use (Wright & Wilson, 2012). Hew and Brush (2007) analyzed existing empirical studies of technology integration from 1995 to spring 2006 in the United States and other countries. Out of six categories of barriers examined, two were related to teachers' behavior: the lack of specific knowledge and skills about technology integration and attitudes and beliefs toward technology (Gu, Zhu, & Guo, 2012). Bingimlas (2009) found teachers had a strong desire to integrate technology into classrooms, but lack confidence and competence, or positive attitudes toward technology. Bingimlas' study has a direct correlation to the findings in my study, which also found teachers' *comfort level with technology use* and *perceptions of technology use* led to deeper levels of technology integration.

In 2005, ISTE published a guide for implementation of technology entitled *Planning for Technology: A Guide to School Administrators, Technology Coordinators, and Curriculum Planners*. This guide provided models of professional development to assist in the implementation of technology. In this guide, there are three models for successful 1:1 implementation: Model 1: Prior to Program Change, Model 2: Subsequent to Program Change, and Model 3: Professional Learning Community (PLC) based.

Model 1: Prior to Program Change is professional development held before the technology is introduced. In my study this would be considered pre-implementation strategies. Teachers have devices before students have devices, and teachers are provided training specific to the use of the device. The idea is to "front load" technical knowledge, pedagogical practice, and content specific training. Teachers are encouraged to experiment with devices, using colleagues to exchange and try new ideas. This was the primary implementation strategy used at Wagner Middle School.

Model 2: Subsequent to Program Change is professional development held during the implementation stage of technology. Teachers and students would receive devices at the same time. In my study this would have been considered concurrent to implementation strategy. This model is considered to the most “hands-on” since both teacher and students have devices. There is a sense of urgency with this model on the part of teachers in order meet the need of students. Professional development is at the point of implementation, and the development is ongoing. “The chief advantage of this model is the close fit between program change and professional development” (Whitehead, 2013). This was the primary strategy used at Mozart Middle School.

Model 3: Professional Learning Community model is the more contemporary approach to professional development. The advantages to this model are the collaboration among colleagues, greater awareness of the initiative, and development of teacher’s leadership capacity. Both Mozart and Wagner Middle School used Professional Learning Communities as an implementation strategy. Rick DuFour (2004) discussed the three big ideas about Professional Learning Communities, which are ensuring that students learn, a culture of collaboration, and a focus on results. DuFour stated, “Powerful collaboration that characterizes professional learning communities is a systematic process in which teachers work together to analyze and improve their classroom practice,” which is the second big idea culture of collaboration (DuFour, p. 6, 2004). Both Wagner and Mozart Middle Schools used Professional Learning Communities; however, these were not specifically analyzed in this study. As a part of Professional Learning Communities, teacher collaboration and work with technology specialists did yield a deeper level of technology integration.

The third finding in this study was digital leadership has no direct correlation to the level of technology implementation. When saying digital leadership, it is inferred this is building level administration. This finding is a contradiction to what most literature on this topic states. During focus groups discussions, teachers at Wagner Middle School overwhelming referenced little to no observed leadership from principals in terms of technology implementation and integration. One of the barriers to 1:1 technology is a lack of vision and leadership at the school level (Machado & Chung, 2015). Although these feelings were discussed within focus groups, it was not reflected in TUPS survey analysis that included a larger sample of responders.

Without a technology vision that is communicated to all stakeholders, school leaders often fail to fully understand and support the role of technology in the school. Many authors suggested that the building principal fills this central organizational and leadership need (Richardson, Flora, & Bathon, 2013). It was clear in focus group conversations from Wagner, this building level leadership did not exist. The literature states that most effective principals develop a vision and use this vision to develop a supportive learning community (Leithwood & Riehl, 2003). School policies flow from the top down and from the bottom up. Therefore, the attitudes toward technology and the actual effectiveness of technology integration in classrooms are shaped by the principal's vision and leadership for their school— in addition to teacher preparation (Machado, 2015).

Learning Forward Standard 2 states the need for leaders to develop capacity, advocate, and create support systems for professional learning. Successful leaders define their values and vision to raise expectations in order to set direction and build trust for organizational change

(Whitehead, 2013). Furthermore, Whitehead stated, "Successful leaders must be able to anticipate change and adapt administrative roles and responsibilities to meet the needs of students and teachers" (p. 22). Both ISTE-C and Learning Forward Standards identify leadership as a major indicator of a successful initiative. School leadership has the greatest impact on teachers in the classroom and is the key factor for successful achievement of a school's organizational goals (Barber et al. 2010). Alan November claimed that leaders also must learn how to support risk-taking teachers and creating cohorts of teachers across disciplines and grades that can promote student-learning change (November, 2013). This study found no relationship to school leadership and the level of technology implementation.

Eric Sheninger (2014) declared it is imperative that school leaders develop a vision for the role that technology will play and establish a strategic plan to for implementation. Additionally, leaders must move with vision transferring to action by emulating the behaviors, techniques, and strategies utilized by highly effective technology leaders. School leadership as it pertains to visioning of the technology implementation was not a part of this study, but could be an area for further research.

The fourth finding is in regard to teacher initiative. My finding is access and support from a technology specialist provided a deeper level of technology integration. Additionally, teacher willingness to accept help from a technology specialist has a direct correlation to a teacher's comfort level with technology use. In order to be successfully coached by a technology specialist, a teacher must first have a positive mindset about technology and then have the initiative to engage in the support.

Since mindset is so important to teachers and their willingness to access support, how can technology specialists reach out more effectively? This finding reflects the importance of technology specialists building relationships with teachers in order to generate trust and comfort levels. Technology specialists must work positively to coach reluctant teachers on a progression of skills allowing for deeper levels of implementation.

Learning Forward Standard 1: “Learning communities” declares professional learning that increases educator effectiveness and results for all students occurs within learning communities committed to continuous improvement, collective responsibility, and goal alignment. Learning Forward Standard 5: “Learning design” states professional learning that increases educator effectiveness and results for all students integrates theories, research, and models of human learning to achieve its intended outcomes. Additionally, Standard 6: “Implementation” states professional learning that increases educator effectiveness and results for all students applies research on change and sustains support for implementation of professional learning for long-term change. All three standards indicate the importance of professional learning as part of any initiative. Of specific importance is the capacity building for teachers as they work with technology specialists to improve their strategies and practices. Furthermore, the opportunity for collaboration is critical. As noted by DuFour, the opportunity to share and problem solve within a community of professionals is critical to the successful implementation of a new model or program. Teachers must have dedicated time to analyze and discuss. They must also be afforded the freedom to experiment and take chances without fear of failure. Teachers involved in focus groups expressed the need for time to practice, implement, and experiment with new technologies, especially when new programs are employed. The need to differentiate pacing is just as important with teacher learning as student learning.

The fifth and final finding pertains to school climate. School climate has a direct relationship to teacher views on work with a technology specialist, perception of technology use, and the level of technology integration. School climate has a strong correlation to the success levels of professional development. Dr. Kent Peterson defined school climate as, “a set of norms, values and beliefs, rituals and ceremonies, symbols and stories that make up the 'persona' of the school" (Peterson & Deal 1998, p 29). A positive school culture is considered one that celebrates successes, emphasizes accomplishments and collaboration, and fosters a commitment to staff and student learning. A negative school culture is defined as an environment that blames students for lack of progress, discourages collaboration, and breeds hostility among staff (Peterson, 2002).

Summary of research question #1. The findings related to this research question confirm that research-based professional development that is sustained, student-centered, participatory, and supported by adequate resources has an impact on the implementation of 1:1 technology, when teachers have a positive perception of technology use. The timing of that professional development, whether before implementation or during implementation, has no significant impact.

A contradiction to most of the research in the literature review is the finding in this study on digital leadership. Digital leadership, which is considered building level administration leadership, did not positively or negatively impact 1:1 technology implementation. Focus group participants responded negatively to the question, “Specifically, how have your administrators supported your reflection and professional growth? Coding analysis found digital leadership with overall negative responses as it pertains to professional development. However, this study found school culture does have an impact on 1:1 implementation. This finding is somewhat puzzling. A vital part of school culture is building leadership. It would seem that both would have an impact. This finding suggests a potential area for additional research.

The final finding is about teacher initiative. Teacher initiative does have an impact on the implementation. This is not surprising and is supported by the research. Teachers who have a high comfort level and positive perception of technology use are willing to ask for assistance from a technology specialist. It is obvious these practices would lead to a deeper level of implementation.

Research Question 2: How do stakeholders perceive changes in instructional practices have occurred since the technology implementation based on the ISTE-Coaching Standards? Quantitative analysis using TUPS survey demonstrated using technology as a presentation tool was statistically significant when compared to 20 other instructional practices surveyed. "Meaningful use of technology" in schools goes far beyond just dropping technology into classrooms" (Dwyer, 2008, p. 6). Additionally, students' academic advances increased the most when teachers moved away from traditional teacher centered learning into project and inquiry-based models. To further extend this thinking, ISTE Teacher Standard 2b and c state: "Engage students in exploring real-world issues and solving authentic problems using digital tools and resources" and "Promote student reflection using collaborative tools to reveal and clarify students' conceptual understanding and thinking, planning, and creative processes" as critical resources for 21st century learning and teaching.

Ninety percent of teachers believe modern technology in the classroom is important to achieving success in preparing students (Ertmer & Ottenbreit-Leftwich, 2010). Although teachers believe in the importance of technology, data from the TIM-O observations recorded classrooms in both schools as predominantly *entry* or *adoption levels* of technology integration. *Entry* and *adoption* are the two lowest level of technology integration measured by TIM-O. The broader sample using TUPS survey concluded comparing the two middle schools Wagner and Mozart with the same instructional practices, there were no statistically significant differences, demonstrating similar practices in both schools. ISTE Coaching Standard 3 outlines the need for effective digital age learning environments to maximize the learning of all students. Although a few classrooms at both Wagner and Mozart Middle Schools achieved high levels of *adaption*, *infusion*, and *transformation* using TIM-O, most classrooms were rated in the lower two levels.

Qualitative analysis from teacher focus groups indicate an overall positive opinion of changes after technology implementation. Of course, this opinion may be somewhat inflated since it is self-reported. Positive changes include: higher student capacity for independent learning, improved student engagement during instruction, and technology used at home as an opportunity for reteaching, video tutorials, learner supports and closing the opportunity gap. Overall, focus group teachers from both schools had positive responses about changes in *student learning*. In a study of 1:1 in five Massachusetts middle schools performed by Bebell and Kay (2010), teacher-observed engagement and student motivation both increased. Results also indicated that 71% of the studied teachers believed that students were more motivated with laptops. Teachers initially concerned about distractions of students with laptops found their students' academic engagement as a substantial benefit of 1:1 computing programs (Bebell et al., 2010). Student distractions was a topic of discussion in focus groups at Wagner Middle School as one of the negatives. Negative aspects of the implementations included lack of home Internet connections, student monitoring while using technology, and student distraction from games and other websites. Home internet connection concerns were isolated to Wagner Middle School which is more rural and has a higher level of free and reduced qualified students.

Summary of research question #2. Changes to instruction are perceived as mostly positive when it comes to technology integration is both Mozart and Wagner Middle Schools. *Using technology as a presentation tool*, was statistically significant when compared to the 20 instructional practices measured in TUPS. Between middle schools there were no statistically significant differences in instructional practices. Focus group discussion in both schools showed positive changes in student capacity for independent learning, improved student engagement during instruction, and technology used at home as an opportunity for reteaching, video tutorials, learner supports and closing the opportunity gap. Negatives shared through focus group discussion included a lack of home Internet connections, student monitoring while using technology, and student distraction from games and other websites.

Research Question 3: When comparing two schools, one using pre-implementation practices and the other concurrent practices, which school has the deepest level of implementation measured by ISTE-Coaching Standards?

Hooper and Rieber (1999) described five phases of teachers' use of technology: familiarization, utilization, integration, reorientation, and evolution. The five stages are defined as: 1) *Familiarization*, learning the "how-tos" of using technology; 2) *Utilization*, trying the technology, but will not miss it if taken away; 3) *Integration*, using technology for certain tasks and designated uses; 4) *Reorientation*, using technology for more than delivery of content; focus is more on student learning and 5) *Evolution*, continuing to evolve, adapting and integrating technology. The concepts from Hooper and Rieber are similar to technology integration levels used in TIM-O of *Entry*, *Adoption*, *Adaption*, *Infusion*, and *Transformation*. Teachers do not typically progress past the *utilization* stage to the *evolution* stage, where they use technology seamlessly in their instruction (Wright, 2011). This finding from Wright is similar to what this study realized. TIM-O observations from both Wagner and Mozart found the vast majority of the teachers observed in the *Entry* and *Adoption* levels of technology integration. Focus group analysis found that overall responses from Mozart Middle School were positive in nature compared to those of Wagner Middle School.

Development of a promising technology does not guarantee that it will achieve widespread use. Teachers will vary in their interest in adopting a new approach, and in their competence to use it. A finding of this study was teacher perceptions of technology use coupled with pre-implementation strategies yielded a statistically significant relationship to a deeper level technology integration.

Content knowledge and professional growth from ISTE-C and Learning Forwards *Learning Design* share similar characteristics confirming the importance of professional knowledge and pedagogical practice in the classroom. A growing number of studies in which teams of teachers act as designers of technology-enhanced learning show those same teachers willingly increase technology integration in their classrooms (Cviko et al. 2013). Additionally, knowledge on the subject of technology integration increasingly promotes teachers' active participation in the design of learning material (Koehler and Mishra, 2005). This study did not measure if teacher-made content increased the level of technology implementation. Current teachers need professional development aimed at technology integration using both the content of their specialization and within the context of the classroom environment (Ruggiero & Mong, 2015). Although this study looked at professional development pre-implementation and concurrent with implementation. The study did not differentiate content specific professional development and if it yielded a higher level of integration. Focus group analysis found teachers from both schools believe in the importance of *Teacher Learning*, but Mozart teachers have more positive attitudes about the training than Wagner. Within the classroom, an instructor must be able to use technology and connect it to the content pedagogically (Stobaugh & Tassell, 2011).

Teachers need time to master the pedagogical practices as these pertain to student computer literacy skills. Wang, Hsu, Reeves, & Costner's (2014) two-year study revealed year one of implementation teachers managed to change their assignment requirements adding technology and started asking students to use technology to work on their projects. In year two, implementation showed considerable improvement on teachers' effort to develop students' new technology literacy skills. Students received more opportunities to practice how to use technology to evaluate, synthesize, and communicate information through these assignments (Wang et al., 2014). During focus group discussion, teachers expressed the need for extended amounts of time to process and learn. However, the student voice was not considered in this study.

Ruggiero and Mong in a 2015 study claimed that current teachers need professional development aimed at technology integration using both the content of their specialization and within the context of the classroom environment (Borko, Whitcomb, & Liston, 2009). Simple exposure to technology would not facilitate 21st century learning skills. Students and teachers need to interact with technology in real world settings in order to make it worthwhile in the subject specific activities. The overall finding as it relates to this question is there was no statistically significant relationship to level of technology integration and whether a school used pre-implementation or concurrent implementation strategies.

Summary of research question #3. Most of the classrooms at both Mozart and Wagner Middle Schools were measured in the lower two levels of *entry* and *adoption* based on TIM-O. This trend aligns with research that declares most classrooms do not move beyond lower levels of technology implementation. A finding of this study indicated *teacher perceptions of technology use* coupled with pre-implementation strategies yielded a statistically significant relationship to a deeper level technology integration. Overall there was no statistically significant relationship between pre-implementation and concurrent to implementation strategies and the level of technology integration at either Wagner and Mozart Middle School.

Research Question 4: What are the differences in ISTEP+ and NWEA assessment data, comparing pre- and post-implementation data of 1:1 technology in both districts?

Claims have been made that 1:1 initiatives have made little to no impact on student learning (such as, Silvernail & Gritter, 2007). The findings of this study support that claim.

Both Wagner and Mozart Middle Schools had either a negative or no impact in achievement scores as measured by ISTEP+. However, some research in this area demonstrates opposite outcomes. Academic achievement results of 1:1 programs have been demonstrated with writing skills. The state of Maine implemented 1:1 computing and student-focused teaching strategies, such as critical thinking, communication, and collaboration (the 3C's), in their middle schools in 2002. Maine students showed significant improvement in writing scores on their statewide testing (Silvernail & Gritter, 2007). Although there is a writing component to ISTEP+, the results of writing sections from that assessment were not directly evaluated. Lowther et al.'s (2012) study also indicated positive achievement gains in students' writing scores with a combination of laptop use and teacher professional development. NWEA data from both schools on average achieved learning goals in math, reading, and language arts. However, overall proficiency rates were either negatively impacted or unchanged.

Additional studies observed gains in both writing and literacy skills. One of those studies analyzed what sometimes occurs as students transition from "learning to read" to "reading to learn" typically in grade 3 to grade 4. The study found that students in a laptop program outperformed their peers in the control group in literacy response and analysis, as well as writing strategies (Bebell et al., 2010). Reading levels were not specifically measured in this study, but reading goals measured by NWEA were met on average at both Wagner and Mozart Middle School.

Summary of research question #4. Assessment data using both NWEA and ISTEP+ had little to no change after technology implementation at Wagner or Mozart Middle Schools.

This aligns with research on the subject of student achievement and technology integration. Although research found increases in student writing proficiency after technology integration, writing was not specifically analyzed at part of the study. NWEA data did show some positive results at both schools as students attained established learning goals in math, reading, and language arts.

Limitations of this Study

The major limitations of the study include observational data, focus group participation, lack of measurement of content specific professional development, and no writing assessment data. For this study, teachers were observed using TIM-O matrix to measure the level of integration. Observations were only performed once. At least two additional observations could have provided better data for quantitative analysis and may have led to statistically significant relationships.

In John Hattie's book *Visible Learning*, which includes 15 years of research about how learners learn best, he concludes feedback is a crucial learning tool. Since results of observations using TIM-O were not shared with teachers, critical information was withheld that could have brought about deeper implementation practices in the classroom. With multiple observations including teacher feedback a better trajectory of improvement and implementation could have been enacted.

Focus group participation at both schools was limited. Although participation in focus groups at Wagner was better than Mozart, both schools failed to attract at least 10 volunteers. Wagner had enough participants for two groups one with 6 participants and the other with 2.

Mozart only had one focus group with 3 participants. Although discussion was rich, it could have been enhanced with additional people and their perspectives.

Professional development in this study was limited to pre-implementation and concurrent to implementation. Content specific professional development, which according to research yielded a deeper level of technology integration, was not used. Survey and observational data could have measured the level of technology implementation and could have provided more in-depth analysis of professional development practice.

Other researchers have found that writing achievement improved as part of technology integration. Although discussion in focus groups in this study had some relationship to writing and improvement, no quantitative data on writing was available. Benchmark writing assessments over the period of technology implementation could have provided a glimpse of how writing achievement had improved.

Implications

For each research question there are implications for the results of this study. First, research-based professional development that is sustained, student-centered, participatory, and supported by adequate resources has an impact on the implementation of 1:1 technology. The success of professional development is contingent upon the positive perception of technology use held by teachers. The timing of that professional development whether before implementation or during implementation has no significant impact on technology integration.

Second, school climate is critical to the implementation of technology. A school climate is needed where teachers are allowed to take risks, collaboration is celebrated, and initiative is respected. This type of school climate encourages work with technology specialists and lead to a deeper level technology integration. Although digital leadership was not statistically significant in this study, digital leadership by the school principal is critical to a positive school climate.

Third, technology integration does change instructional practice. In this study, student use of technology as a presentation tool was considered significant. Access to technology does close the opportunity gap for students who would otherwise not have a device at home. Devices at home provide opportunities for students to complete homework, have access to reteaching and tutorials. Technology does improve student’s capacity to learn independently and teachers feel students are more engaged in learning using technology.

Fourth, a more in-depth look at digital leadership could better define the role of building leadership and its effect on technology implementation. A closer look at administrator professional development and how that training created personal proficiency with technology could be identified. Such training enables leaders to effectively model best practices in their own technology use. Beyond technical proficiency, what kind of training is provided to school leaders on identifying best practices in pedagogy and content using a 1:1 technology?

Finally, most teachers are challenged to move to higher levels of technology integration. TIM-O matrix indicated most teachers in *entry* and *adoption* levels of technology integration. In order for more teachers to progress to higher levels of integration, such as *adaption*, *infusion*, and *transformation*, teachers must find a comfort level with technology use and feel that technology belongs in their classroom. Moving to higher levels of technology integration should have an impact on student learning and eventually student assessment data like ISTEP+ and NWEA.

Recommendations

Areas for consideration to further expand this investigation of the relationship of professional development to technology integration at the middle school level include duration of the study, using additional assessment data beyond standardized testing, and including the student voice. This study examined assessment data for only the years where technology was fully integrated into classrooms. Preliminary 2018 ISTEP+ data at Wagner Middle School revealed significantly increased pass rates for 8th grade students. This spring concluded the fourth year of technology integration at Wagner Middle School. It is unclear if Mozart Middle School had the same increase in pass rate. Focus group discussion reflected upon the need for teachers to have time to integrate technology. A current longitudinal study of technology integration and student achievement should be considered.

Standardized assessment data does not always effectively measure student achievement. Often standardized assessments discriminate against students from low socioeconomic status and diversity. Using benchmark assessments that can measure improvement in writing and on a longitudinal basis might better measure student achievement.

The importance of digital leadership is a well-documented finding in many studies. However, this study found school climate as statistically significant, but not digital leadership. Further study might include the importance of digital leadership as it relates to school culture within the narrow perspective of technology implementation and integration.

This study primarily focused on the teacher voice. A future study could include the voice of students. What would be the perceptions of students on how technology integration has changed instruction? What types of learning truly engage students? Student voice might reflect a different level of integration than that of teachers. Therefore, creating a study where all stakeholders' perceptions are reflected would be recommended.

Concluding Remarks

The study investigated the relationship between professional development and technology integration in the middle school classroom. This study was designed to explore the relationship between the strategies that provide the deepest level of technology integration: professional development before technology implementation, concurrent to implementation, digital leadership, teacher initiative, or school culture. The results of this study conclude that the timing of professional development have no relationship to the level of technology integration. Teacher initiative and attitudes as well as school climate have a positive relationship to the level of technology of technology integration. The results were consistent with studies discussed in Chapter 2. Exploring certain aspects of these relationships further could reveal additional strategies and practices that could change instruction and provide a deeper level of technology integration. "21st Century Education won't be defined by any new technology. It won't be just defined by 1:1 technology programs or tech-intensive projects. 21st Century Education will, however, be defined by a fundamental shift in what we are teaching - a shift towards learner-centered education and creating creative thinkers." Karl Fisch

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APPENDIX

Appendix A-ISTE-Coaches Standards

International Society for Technology Education Coaches Standards

1. Visionary Leadership

Technology Coaches inspire and participate in the development and implementation of a shared vision for the comprehensive integration of technology to promote excellence and support transformational change throughout the instructional environment.

a. Contribute to the development, communication, and implementation of a shared vision for the comprehensive use of technology to support a digital-age education for all students

b. Contribute to the planning, development, communication, implementation, and evaluation of technology-infused strategic plans at the district and school levels

c. Advocate for policies, procedures, programs, and funding strategies to support implementation of the shared vision represented in the school and district technology plans and guidelines

d. Implement strategies for initiating and sustaining technology innovations and manage the change process in schools and classrooms

2. Teaching, learning, and assessments

Technology Coaches assist teachers in using technology effectively for assessing student learning, differentiating instruction, and providing rigorous, relevant, and engaging learning experiences for all students.

a. Coach teachers in and models design and implementation of technology-enhanced learning experiences addressing content standards and student technology standards

b. Coach teachers in and model design and implementation of technology enhanced learning experiences using a variety of research-based, learner centered instructional strategies and assessment tools to address the diverse needs and interests of all students

c. Coach teachers in and model engagement of students in local and global interdisciplinary units in which technology helps students assume professional roles, research real-world problems, collaborate with others, and produce products that are meaningful and useful to a wide audience

d. Coach teachers in and model design and implementation to technology-enhanced learning experiences emphasizing creativity, higher-order thinking skills and mental practices of mind (e.g., critical thinking, metacognition, and self regulation)

e. Coach teachers in and model design and implementation of technology enhanced learning experiences using differentiation, including adjusted content, process, product and learning environment based upon student readiness levels, learning styles, interests, and personal goals.

f. Coach teachers in and model incorporation of research-based best practices instructional design when planning technology-enhanced learning experiences

g. Coach teachers in and model effective use of technology tools and resources to continuously assess student learning and technology literacy by applying a rich variety of formative and summative assessments aligned with content and student technology standards

h. Coach teachers in and model effective use of technology tools and resources to systematically collect and analyze student achievement data, interpret results, and communicate findings to improve instructional practice and maximize student learning

3. Digital age learning environments

Technology coaches creates and support effective digital age learning environments to maximize the learning of all students.

a. Model effective classroom management and collaborative learning strategies to maximize teacher and student use of digital tools and resources and access to technology-rich learning environments

b. Maintain and manage a variety of digital tools and resources for teacher and student use in technology-rich learning environments

c. Coach teachers in and model use of online and blended learning, digital content, and collaborative learning networks to support and extend student learning as well as expand opportunities and choices for online professional development for teachers and administrators

d. Select, evaluate, and facilitate the use of adaptive and assistive technologies to support student learning

e. Troubleshoot basic software, hardware, and connectivity problems common in digital learning environments

f. Collaborate with teachers and administrators to select and evaluate digital tools and resources that enhance teaching and learning and are compatible with school technology infrastructure

g. Use digital communication and collaborative tools to communicate locally and globally with students, parents, peers and the larger community

4. Professional development and program evaluation

Technology coaches conduct needs assessments, develop technology-related professional learning programs, and evaluate the impact on impact on instructional practice and student learning

a. Conduct needs assessments to inform the content and delivery of technology-related professional learning programs that result in a positive impact on student learning

b. Design, develop, and implement technology-rich professional learning programs that model principles of adult learning and promote digital age best practices in teaching, learning, and assessment

c. Evaluation results of professional learning programs to determine the effectiveness on deepening teacher content knowledge, improving teacher pedagogical and/or increasing student learning

5. Engage in professional growth and leadership

Technology coaches model and promote digital citizenship

a. Model and promote strategies for achieving equitable access to digital tools and resources and technology-related best practices for all students and teachers

b. Model and facilitate safe, healthy, legal, and ethical uses of digital information and technologies

c. Model and promote diversity, cultural understanding, and global awareness by using digital age communication and collaboration tools to interact locally and globally with students, peers, parents, and the larger community

6. Content knowledge and professional growth

Technology coaches demonstrate professional knowledge, skills, and dispositions in content, pedagogical, and technological areas as well as adult learning and leadership and are continuously deepening their knowledge and expertise

a. Engage in continual learning to deepen content and pedagogical knowledge in technology integration and current and emerging technologies necessary to effectively implement the ISTE Student and Teacher Standards

b. Engage in continuous learning to deepen professional knowledge, skills, and dispositions in organizational change and leadership, project management, and adult learning to improve professional practices

c. Regularly evaluate and reflect on their professional practice and dispositions to effectively model and facilitate technology-enhanced learning experiences

Appendix B-Survey

Gender

Total Teaching Experience in Years

How Many Years Have You Used Technology for Instruction?

What subject area do you teach?

What grade levels do you currently teach?

Ethnicity

Technology Access and Support

1. I have adequate access to a technology specialist.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. The technology specialist adequately assists me in solving technical problems with hardware or software.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. The technology specialist is committed to helping teachers find solutions.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. The technology specialist responds promptly to my requests for assistance

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. The technology specialist models techniques to integrate technology into my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. The technology specialist provides professional development.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. The technology specialist adequately assists me in planning and implementing the use of technology in my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Preparation for Technology Use

For the following items, please select the one response that best reflects the extent to which you've acquired technology skills from the following sources.

1. As a part of my undergraduate coursework

Not at All	To a Small Extent	To a Moderate Extent	To a Great Extent	Entirely

2. In-service courses or workshops

Not at All	To a Small Extent	To a Moderate Extent	To a Great Extent	Entirely

3. Independent learning (e.g. online tutorials or books)

Not at All	To a Small Extent	To a Moderate Extent	To a Great Extent	Entirely

4. Distance learning courses

Not at All	To a Small Extent	To a Moderate Extent	To a Great Extent	Entirely

5. Interaction with colleagues

Not at All	To a Small Extent	To a Moderate Extent	To a Great Extent	Entirely

6. Interaction with others (e.g., friends, family, etc.)

Not at All	To a Small Extent	To a Moderate Extent	To a Great Extent	Entirely

Perceptions of Technology Use

Please read the following statements and select the one response that best reflects your level of agreement.

1. I would like every student in my class(es) to have access to a digital device.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. Technology skills are essential to my students' success in school.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. Technology skills are essential to my students' success in their future workplace.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. More training would increase my use of technology in my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. Technology makes my job easier.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. Technology changes my role as a teacher.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. I can help others solve technology problems.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. Technology enhances my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. Student use of technology enhances student performance.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. My use of technology enhances student performance.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. Technology should be used in all courses.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. I would like my students to be able to use technology more in their classes.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Confidence and Comfort Using Technology

Please read the following statements and select the one response that best reflects your level of agreement.

1. I have had adequate training in technology use.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. I currently have adequate opportunities for technology training in my school.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. I am prepared to effectively integrate technology into my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. I am prepared to assess multimedia projects.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. I am prepared to guide other teachers in planning and implementing lessons that incorporate technology.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. I am comfortable using technology in my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. I am comfortable assigning multimedia projects to my students.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. I use technology effectively in my teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. I am developing expertise in the uses of technology in teaching.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. I am prepared to recognize the unethical uses of technology.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. I am comfortable teaching my students about copyright and fair use guidelines.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Technology Integration

Listed below are teaching modes in which technology may be used. Please select the response that best indicates how often you use technology in each teaching mode.

1. Small group instruction

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

2. Individual instruction

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

3. Cooperative groups

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

4. Independent learning

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

5. As an extension activity

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

6. As a reward

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

7. To tutor / for remediation

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

8. As a research tool for my students

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

9. As a tool for students to use in planning and managing projects (individual and group)

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

10. As a productivity tool for my instruction (e.g., to create charts, reports or other products)

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

11. As a student presentation tool (including multimedia)

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

12. Student discussion/communication

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

13. Instructional delivery

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

14. As a communication tool (e.g., email, electronic discussion)

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

15. To create online content for my students (web pages, blogs, etc.)

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

16. To assess student learning

Not at All	Once per Month or Less	Once Per Week	Several Times Per Week	Every Day	Multiple Times Per Day

Teacher Resources: Select the response for each statement below that best represents your thinking.

1. From which source do you most frequently seek guidance, information, inspiration, and/or direction relating to your classroom use of digital resources in the classroom?

    - Students
    - Building Administrators
    - School/District Specialists (e.g., Media/Technology Specialist, Instructional Specialist)
    - Classroom Teachers (e.g., Other Colleagues, Mentors, Peer Coaches)
    - Specific websites (e.g., Teaching Channel, YouTube, Kahn Academy, Online Subscriptions)
    - Other (e.g., College Professor, Conference Presenter, Business/Community Member, Vendor)

2. Select the statement below that best represents your current level of comfort using technology in a classroom setting:

- I LOVE technology. I think it has endless potential to create deeper learning opportunities for everyone and needs to be infused into every level of the school experience.
- Technology can be very useful for certain things – When I need it, I'm glad that it's there. It is becoming a much bigger part of our lives than it has been in the past and sometimes I wonder about how this is impacting children who are growing up in hi-tech environments, and what it means for education...
- I see others using technology and I think it looks interesting, but I don't know if it's my style. Even though it's in the back of my mind, I still plan lessons and activities that won't require the use of any technology. I work it in a little bit when I can, but overall, I feel more confident if I know I can teach a lesson without it.
- Technology is SO frustrating – not to mention a big waste of time. Usually I can't figure out how anything works, and when I think I get it, something changes or goes wrong and it just ends up interfering with what I want to accomplish. Besides, all I see kids doing on computers is playing games and watching videos. I don't use computers, cell phones, etc. unless I absolutely have to, and I'm not interested in learning!

- What do you perceive as the greatest obstacle to advancing your use of digital resources in your instructional setting?
  - None
  - Lack of Access to Digital Resources

- Time to Learn, Practice, and Plan
- Required Instructional Priorities (e.g., Statewide Testing, New Textbook Adoptions)
- Lack of Staff Development Opportunities
- Other

Teacher Perceptions of Professional Development: Select the response for each statement below that best represents your perceptions about the use of digital resources in your classroom.

1. I believe professional development received before student device rollout positively impacted my ability to integrate technology.

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

1. I believe professional development received after student device rollout positively impacted my ability to integrate technology.

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

2. I receive useful feedback on the integration of digital resources into my instruction from my administrator(s).

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

School Climate Select the response for each statement below that best represents your perceptions about the educational climate at your school.

1. I am treated as a respected educational professional on my campus.

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

2. I engage in a two-way cycle of communication and feedback with my school administrators.

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

3. I feel that my voice is listened to and shared with other stakeholders on campus.

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

4. I understand and support the shared vision for our school's use of digital resources.

Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

Appendix C Classroom Observations: TUPS Matrix

LEVELS OF TECHNOLOGY INTEGRATION → CHARACTERISTICS OF THE LEARNING ENVIRONMENT ↓	**ENTRY LEVEL** The teacher begins to use technology tools to deliver curriculum content to students.	**ADOPTION LEVEL** The teacher directs students in the conventional and procedural use of technology tools.	**ADAPTATION LEVEL** The teacher facilitates students in exploring and independently using technology tools.	**INFUSION LEVEL** The teacher provides the learning context and the students choose the technology tools to achieve the outcome.	**TRANSFORMATION LEVEL** The teacher encourages the innovative use of technology tools. Technology tools are used to facilitate higher order learning activities that may not have been possible without the use of technology.
ACTIVE LEARNING Students are actively engaged in using technology as a tool rather than passively receiving information from the technology.	**Active Entry** Information passively received	**Active Adoption** Conventional, procedural use of tools	**Active Adaptation** Conventional independent use of tools; some student choice and exploration	**Active Infusion** Choice of tools and regular, self-directed use	**Active Transformation** Extensive and unconventional use of tools
COLLABORATIVE LEARNING Students use technology tools to collaborate with others rather than working individually at all times.	**Collaborative Entry** Individual student use of tools	**Collaborative Adoption** Collaborative use of tools in conventional ways	**Collaborative Adaptation** Collaborative use of tools; some student choice and exploration	**Collaborative Infusion** Choice of tools and regular use for collaboration	**Collaborative Transformation** Collaboration with peers and outside resources in ways not possible without technology
CONSTRUCTIVE LEARNING Students use technology tools to connect new information to their prior knowledge rather than to passively receive information.	**Constructive Entry** Information delivered to students	**Constructive Adoption** Guided, conventional use for building knowledge	**Constructive Adaptation** Independent use for building knowledge; some student choice and exploration	**Constructive Infusion** Choice and regular use for building knowledge	**Constructive Transformation** Extensive and unconventional use of technology tools to build knowledge
AUTHENTIC LEARNING Students use technology tools to link learning activities to the world beyond the instructional setting rather than working on decontextualized assignments.	**Authentic Entry** Use unrelated to the world outside of the instructional setting	**Authentic Adoption** Guided use in activities with some meaningful context	**Authentic Adaptation** Independent use in activities connected to students' lives; some student choice and exploration	**Authentic Infusion** Choice of tools and regular use in meaningful activities	**Authentic Transformation** Innovative use for higher order learning activities in a local or global context
GOAL-DIRECTED LEARNING Students use technology tools to set goals, plan activities, monitor progress, and evaluate results rather than simply completing assignments without reflection.	**Goal-Directed Entry** Directions given; step-by-step task monitoring	**Goal-Directed Adoption** Conventional and procedural use of tools to plan or monitor	**Goal-Directed Adaptation** Purposeful use of tools to plan and monitor; some student choice and exploration	**Goal-Directed Infusion** Flexible and seamless use of tools to plan and monitor	**Goal-Directed Transformation** Extensive and higher order use of tools to plan and monitor

Appendix D

Google Form for Teacher Volunteers:

Teacher First Name

Teacher Last Name

Teacher Email Address

Subject You Teach

Are you willing to participate in classroom observations as part of my study? Yes/No

Appendix E Focus Group Questions

1. How has the increased integration of technology affected student learning? How has your instruction changed since the implementation of the 1:1? Specifically, how have your administrators supported student learning?
2. How well does your professional development model the way technology should be used to increase student learning? Would you provide an example of how that has changed based on your implementation of 1:1?
3. How are your beliefs formed and supported through professional learning communities?
4. Specifically, how have your administrators supported your reflection and professional growth?
5. What has been a benefit or strength that has occurred because of the 1:1 implementation?
6. If we were to implement a 1:1 on other schools in the future, what would be important changes we should make to better support teachers (probe if needed about the ideal time to begin PD)?